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SUPPLEMENT TO THE CHEMICAL NEWS, JULY 6, 1888.

THE

CHEMICAL NEWS

AND

JOURNAL OF PHYSICAL SCIENCE.

WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE."

A Journal of Practical Chemistry

IN ALL ITS APPLICATIONS TO

PHARMACY, ARTS, AND MANUFACTURES.

EDITED BY

WILLIAM CROOKES, F.R.S., &c.

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THE CHEMICAL NEWS.

VOLUME LVII.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

No. 1467.—JANUARY 6, 1888.

ON THE OCCURRENCES OF CHROME IRON ORE IN AUSTRALASIA.

By R. W. EMERSON MACIVOR, F.I.C., F.R.G.S., F.C.S.

As I have had occasion to examine the deposits of chrome iron ore which occur in different parts of Australasia, with the view of turning them to commercial account, perhaps the following notes may have an interest for chemists, mineralogists, and manufacturers.

The ore is found in quantity in two or three places in New Zealand, but chiefly in the neighbourhood of Nelson, in the Middle Island. It exists in various forms, distributed throughout what is locally known as "the Mineral Belt"—a broad band of serpentinous and olivine rocks, which can be traced for a distance of about fifty miles from D'Urville's Island in Cook's Straits to the mountain called Little Ben Nevis. These varieties are:—(1) *Massive Crystalline*, in bands of black, highly crystalline character, which, on being fractured, show distinct planes of octahedron, and sometimes—though rarely—perfect crystals. (2.) *Massive Amorphous*, having a brown-black appearance, and somewhat softer in nature than the preceding. This form is usually met with in well-defined bands, which, unlike those of the crystalline massive variety, are remarkable for length and breadth. (3.) *Crystalline Disseminated*, in the condition of nodules, or spherical segregations, having a diameter of from 1-10th to ½in., distributed more or less evenly through the green serpentinous rocks. This ore presents somewhat the appearance of a conglomerate, and is called "pudding stone" by the local miners. On exposure for a week or two to rain and sun the rock loses its green colour and crumbles away to a soft impalpable white powder, leaving the nodules of chromite so that they can be easily and completely separated by mere washing or screening. The nodules have a fracture identical with that of the massive crystalline variety, and are very rich in chromic oxide.

In order to convey an idea of the mode of occurrence of the several kinds of ore in the same mine, perhaps the accompanying rough sketch of an open working, made under my direction on the summit of Little Ben Nevis, may be useful.

A, A, A are seams of dark green rock containing nodular chromite between the layers of massive crystalline ore; C, C, C and B, B, B are patches of "pudding stone."

The face of the working was about 150 feet wide, and nearly 50 feet in height. It will be seen that the crystalline massive ore occurs in "patches" or "pockets," and in these in seams which approach the vertical in position, whereas the amorphous massive variety exists in lodes more or less approaching the horizontal. It may be remarked that much of the "pudding stone" consists of segregations held together by only a small proportion of rock, from which they can be readily separated, even without weathering. From 15 tons of the stone I have obtained as much as 13½ tons of chromite free from matrix, while from the same weight of a poorer sort only 3¼ tons were obtained. No difference, however, existed in the quality of the nodules themselves, as they contained from 59·8 to 68·9 per cent of chromic oxide, whether obtained from rich or poor "pudding stone." The largest "pocket" of crystalline massive ore which I found at Ben Nevis contained about 68 tons of 55 to 62 per cent stone.

How far my observations concerning Ben Nevis are applicable to other parts of "the Mineral Belt" it is difficult to say, though the long experience of the late Mr. T. R. Hacket, who worked the Dun Mountain for an English company, seems to indicate that the richest ores do not occur in well-defined lodes of any length, but rather in the detached "patches" or "pockets" I have described. I am satisfied, however, that the sleepy little city of Nelson will some day reap much benefit from the working up of the vast stores of chrome iron ore in its vicinity. The following is a statement of the percentages of chromic oxide in the ores occurring within easy distance of the town and nearly all on the line of "the Mineral Belt":—

Aniseed Valley:—	
(a.) Crystalline Massive ..	52 to 56
(b.) Amorphous ,, ..	42 ,, 51
(c.) Nodular	56 ,, 69
Adam's Lode:—	
Crystalline Massive	57 ,, 65
Maungatapu:—	
(a.) Crystalline Massive ..	53 ,, 64
(b.) Amorphous ,, ..	30 ,, 50
Croxilles:—	
(a.) Amorphous Massive ..	40 ,, 46

The average ore of the Province of Nelson could easily be maintained at 55 per cent of chromic oxide—and even 60 per cent is possible.

Chromite, as I have already hinted, is also found in other localities in Southern New Zealand, but it has not been met with in the North Island in sufficient quantity to attract attention.

The ore has been extensively exported from New Caledonia during recent years, and judging from some large cargoes which I examined in Sydney, appears to be in many respects similar to the Ben Nevis stone. The

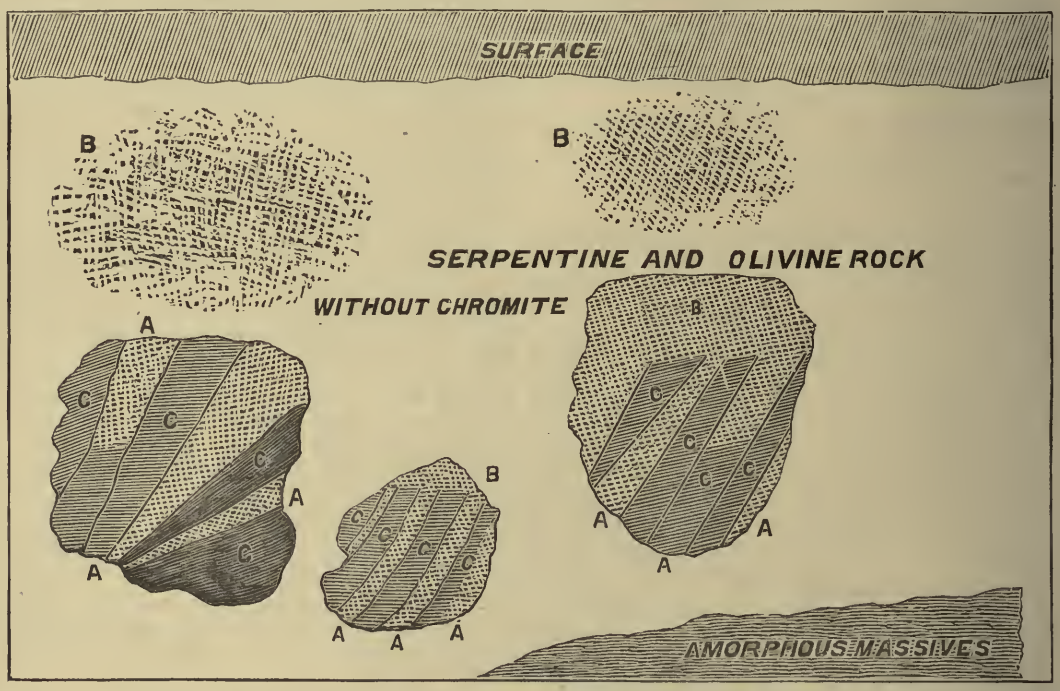
mines are situated about 20 miles from Noumea, the capital of the colony, and the abundance of cheap native labour available for conveying it to shipboard enable the exporters to do their work much more cheaply than is possible in either New Zealand or Australia.

Neither Victoria nor South Australia has yet been found to possess any very extensive deposits of chromite, though in the former colony a considerable quantity of good ore is said to exist in the shire of McIvor.

Large quantities of the mineral occur in the serpentine formations at Jundagai and Tamworth in New South Wales, but the cost of labour, railway carriage, and the present low price of even the best stone, will prevent the supplies from being utilised for a long time to come.

Chrome ore has been discovered in many localities in Queensland, but for most part in places which are at present all but inacessible. It can, however, be obtained in any quantity in and around the Pine Mountain district, near Ipswich, where there are are large areas of serpentine country. The ore is of the amorphous and crystalline massive varieties, and contains from 42 to 60 per cent of chromic oxide. Mines could be opened up very cheaply, and there is ample facility for bringing the ore to Europe.

That there is abundance of chromite in Tasmania I have no doubt whatever, but even if it should be found on the coast the difficulties in the way of shipping it will prevent anything like extensive mining operations for many years to come. Though somewhat foreign to the object of this communication, I may mention where the unexpected occurrence of the mineral did a serious injury to the industrial progress of the whole colony. On the Tamer River, opposite Georgetown, extensive works were put up at a cost of nearly £100,000 to utilise the splendid deposits of rich hæmatite in the locality, but it was soon found that the pig-iron obtained was not marketable in the colonies, owing to its containing from 3 to 7 per cent. of chromium, and the whole enterprise forthwith collaped. The hæmatite occurred in a serpentine formation, and there were disseminated throughout its mass minute veins of chromite. Hence the chromeisen obtained from the blast furnaces.



ATTEMPT AT A DIAGNOSIS OF THE VOLATILE ALKALOIDS.

By M. OECHSNER DE CONINCK.

We may characterise a pyridic alkaloid, following the order of the reactions indicated previously.

First reaction:—We obtain deep red solutions, the tint of which is brightened by acids and destroyed by alkalies in excess. These solutions do not generally become fluorescent.

Second reaction:—We obtain at first neutral colours of a deep red colour, brightened by acids and destroyed by an excess of alkali; their solutions in different mediums (water, ether, alcohols) become very fluorescent after about 10 to 15 hours. There is then formation of pyridic dihydrides highly reductive and possessing a very peculiar odour. In the final stage of the distillation hydrocarbons may be collected over water.

Third reaction:—We obtain solutions having a fine fluorescence; a part of the alkaloid is regenerated, another part hydrogenised, and the hydride formed has a strongly reductive action.

Fourth reaction:—There is formation of a double platium salt.

Fifth reaction:—The chloraurate formed is generally more stable than the chloroplatinate in presence of boiling water. Still, in certain conditions, it may lose 1 mol. of HCl.

Sixth reaction:—There is formed principally a dipyridyle, a thick, oily liquid, heavier than water, and very slightly soluble in it.

Dihydropyridic Alkaloids present coloured reactions which are very fugitive. Luke-warm water modifies their chlroroplatinates, often decomposing them. The chloraurates are rapidly reduced in the acids.

Hexahydropyridic Alkaloids.—Under this name are included a number of well-known alkaloids, such as piperidine and cicutine. Their iodomethylates and iodoethylates do not yield coloured reactions; their gold and platinum salts are sometimes stable and sometimes unstable, and are

not polymerised by sodium. This metal converts some of them into derivatives, which are decomposed by water with regeneration of the alkaloid.

Dipyridic Alkaloids.—Their iodomethylates give very distinct colour reactions with potassa. Their platinum and gold salts are sometimes stable (nicotine), sometimes unstable (sparteine). If the liquid is distinctly acid the stability of these salts is most frequently increased.

Hydrodipyridic Alkaloids yield coloured reactions analogous to those of the dipyridic bases, but more fugitive. The salts of gold and platinum are very unstable.

Quinoleic Alkaloids.—Their iodomethylates and iodoethylates yield coloured reactions, due to the formation of *cyanines*, and give rise to crystalline colouring matters. The gold and platinum salts are stable in presence of boiling water. The chloroplatinates are modified only in presence of an excess of free base. They are polymerised by sodium.

Tetrahydroquinoleic Alkaloids.—Coloured reactions fugitive in consequence of phenomena of reduction. The salts of gold are decomposed in the cold; those of platinum are more stable, but are modified by hot water.

Aromatic Bases, their iodomethylates, &c., do not give coloured reactions with potassa. The platinum and gold salts very stable, or very unstable in presence of water. Not polymerised by sodium.

Bases of the Fatty Series.—Their iodomethylates do not yield colour reactions in an alkaline medium. The platinum and gold salts generally very persistent in the presence of water. Not polymerised by sodium.—*Comptes Rendus* (Vol. cv., No. 25, p. 1258).

ANALYSIS OF A CRYSTALLINE SCALE FORMED IN THE MANUFACTURE OF SODIC BICARBONATE BY THE AMMONIA PROCESS AT SYRACUSE, N.Y.*

By GEORGE W. LEIGHTON.

The material here described was deposited on the inner surface of an iron tank in which vapours consisting of NH_3,CO_2, with small quantities of H_2S, are passed through brine holding in solution NaCl, $MgCl_2$, $CaCl_2$, and $CaSO_4$. It has the appearance of a boiler scale from one to two inches thick, semi-transparent, with a vitreous lustre and of greenish grey colour, although sometimes black on the surface. The scale is usually covered with crystal planes, which have at first sight the appearance of octahedral forms projecting from the surface, but on closer examination the planes were found to be the terminations of prisms extending down into the body of the scale. The faces were somewhat curved, and so irregular as to render accurate measurements with the reflecting goniometer impossible. Attempts were made to obtain approximate values by cementing to the faces bits of thin microscope glass, but the results were discordant. The crystals seemed to have a monoclinic habit, and to consist of an oblique rhombic prism terminated by two pairs of planes of the positive and negative hemioctahedrons. For the prismatic angle we obtained 57° 46', and for the positive and negative octahedral angles an average of 69° and 75° respectively, but with a variation of more than three degrees between measurements on different crystals. We observed a well-marked cleavage parallel to the assumed plane of symmetry; also a second cleavage—inclined to the prismatic edges, and marked by striations on the prismatic planes—parallel to the assumed basal section. There were also indications of both ortho- and clinodomes; and from these features, as well as from the mode of twinning, it is highly probable that the crystallisation is monoclinic, but the evidence is not conclusive.

A qualitative analysis showed that the material was composed chiefly of sodium and magnesium in combination with carbonic acid and chlorine, with a small amount of calcium, and a trace only of iron. The scale, when pulverised, was decomposed by water, all of the sodium salts and part of the magnesium passing into solution upon digestion with a sufficiently large volume of boiling water, but from this solution all the magnesium was thrown down on concentration as carbonate.

In the quantitative analysis the alkali was determined in two ways; first, by extraction of the sodium salts with water and the separation of the magnesium by concentration; secondly, by the regular Lawrence Smith method; and concordant results were thus obtained. The magnesium, calcium, and iron were separated in the usual way. Chlorine was determined by precipitation with argentic nitrate from a solution of the scale in nitric acid, and the CO_2 was determined by loss on treating with acid in a small apparatus adapted for the purpose, and also by absorption in potash bulbs. The results are given below.

Taking now the means of these determinations, and assuming that the chlorine is combined with sodium, while the carbonic acid is distributed among the rest of the base, we obtain as the final average result of the analysis:—

	Found.	Theory.	Diff.
NaCl	22·230	22·23	
Na_2CO_3	40·622	40·28	−0·34
$MgCO_3$	31·569	31·92	+0·35
$CaCO_3$.	3·559		
$FeCO_3$.	0·080		
H_2O	0·630		
CO_2 in excess ..	0·645		
	99·335		

It will be noticed that CO_2 is present in slight excess over the amount required to form neutral carbonates, indicating a small admixture of bicarbonate. The water is obviously hygroscopic, and the minute amount of iron an impurity. Excluding also from consideration the small amount of lime whose relations to the mass cannot certainly be determined, it appears that the three chief ingredients of the crystalline scale are present very closely in the proportion of their molecular weights. This is shown in the column headed Theory, which gives the amounts of Na_2CO_3 and $MgCO_3$ corresponding to the amount of NaCl found in the material analysed, on the assumption that this is a triple salt represented by the symbol $MgCO_3.Na_2CO_3.NaCl$.

By comparing the determinations of chlorine which form the basis of this calculation, it will be seen that the amount of NaCl must be known with great accuracy, and

* *Proceedings of the American Academy of Arts and Sciences.*

Substance estimated.	Number of Analysis. 1.	2.	3.	4.	5.	6.	7.	8.
H_2O at 100° C. ..					0·31	0·39	0·395	
H_2O at 230° C. ..	0·63	0·63						
CaO			2·02	1·99	1·96	1·96	2·05	
FeO	0·045	0·054						
MgO			14·90	14·77		15·34	15·12	
Na_2O	38·71		38·45	38·57				
Cl	13·45		13·46	13·45				
CO_2	36·24			35·33	35·65	35·46		35·54

the column of differences shows that the calculated values of $MgCO_3$ and Na_2CO_3 differ from results of analysis within the limits of experimental errors. By withdrawing from the total weight the small amount of base assumed to exist as bicarbonate, corresponding to the excess of CO_2 shown by analysis, and making also the very probable assumption that the calcium found replaces the magnesium in the triple salt, we should obtain very nearly the same results as before; but such a calculation would rest on uncertain data, and add nothing to the strength of our general conclusion.

It is evident that the crystalline scale is a double carbonate of magnesium and sodium united in molecular proportions with common salt, and mixed with a small amount of impurity; but the amount of impurity is very small, considering the conditions under which the scale is formed. That the chloride is combined, and not simply mixed with the carbonate, is shown, not only by the definite proportions, but also by the fact that the material is so slowly acted on by water, which evidently acts as a decomposing agent, and not solely as a solvent. The scale is then a definite crystalline product, having a very interesting constitution, not unlike that of several well-defined mineral species.

LEAD SLAGS.

By MALVERN W. ILES.

Smelting is a chemical operation, and a study of the nature of slags forms the science of smelting. It will therefore be seen that the field is an exceedingly broad one, and that even in the treatment of a particular kind or class of slags, as produced by shaft furnaces for the treatment of argentiferous lead ores, it will not be possible within the limits of this paper to give all of the important data, but simply to briefly state such salient points as have come within the notice and experience of the writer. The subjects discussed will be classified as follows:—

I. *Physical Properties.*—(1) Density. (2) Crystalline form. (3) Colour. (4) Lustre. (5) Fluidity. 6. Fusibility. (7) Magnetism. (8) Friability. (9) Influence of slow and rapid cooling.

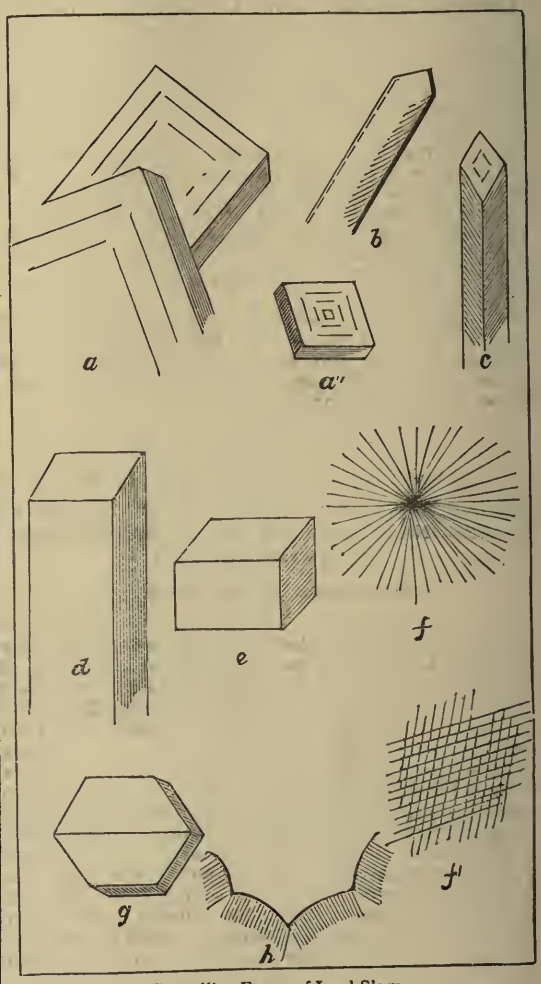
II. *Chemical Properties.*—(1) General composition. (2) Modes of decomposition. (3) Quantitative analysis. (4) Analytical data. (5) Types.

Physical Properties.

Density.—The specific gravity of slags formed in argentiferous lead smelting has been found to be very variable. The minimum noted was 3·3, and the maximum 4·16; the best slags, however, may be stated to have a density of 3·4 to 3·65. Iron, barium, and lead cause high specific gravities, while silica, lime, and alumina have a tendency to diminish the weight. The average density of one hundred samples taken daily in 1880, at Leadville, during very fair work, was found to be 3·691. A series of experiments was conducted on this subject for over a year without arriving at any very positive or satisfactory results. It is now believed that difference in density alone cannot be used as an infallible guide, but should only be regarded as an auxiliary for a thorough study of slags.

Crystalline Form.—Most slags show some tendency towards crystallisation. A few have been noted in which the crystallisation was very imperfect, yet the silver and lead losses were small; these, however, were exceptions, and not the rule. In general the more crystalline a slag is the better it is, considered both from an economical and a metallurgical standpoint.

The centre or "heart" of a cooled pot or cone of slag is always found to be the most crystalline: this tendency diminishes outwardly in all directions until next to the surface is a thin crust or scale devoid of a crystalline structure, and presenting a thin vitreous or glassy scale. This scale is the result of rapid cooling of the slag as it comes in contact with the iron pot. If the grade of bullion produced is not quite high (say over 300 ounces of silver per ton), and the lead charge is not very low, it is rare to find a very crystalline slag containing more than 1 per cent of lead or more than 2 ounces of silver per ton; generally these markedly crystalline slags show a much smaller loss than this. A very careful study of the crystalline form of lead slags will unquestionably enable a skilled metallurgist to identify the type of slag produced,



Crystalline Forms of Lead Slags.

to tell within reasonably close limits the general composition, and to form a comprehensive idea as to the losses in both lead and silver.

The most important crystalline forms of slags are either large thick plates or leaves; thin plates, often semi-translucent and frequently marked with striæ; monoclinic prisms, which may be either inclined or rectangular; several modifications of the cube; delicate needles, which may or may not radiate from a central nucleus; hexagonal plates; and lastly, what may be termed for convenience botryoidal and pectolitic crystallisation. These various forms are shown in the diagrams here given. There seems to be a distinct connection or relation between the crystalline form and the chemical composition of these

slags, as it will be endeavoured to show when the subject of "types" is considered.

Colour.—Lead slags are almost always black, or of some dark shade. The darkest slags are those containing the most iron; yet iron will sometimes give either a reddish tint, due to the presence of a small amount of Fe_2O_3, or have a slight greenish cast. Lime tends to lighten the colour, giving the slag a stony or earthy appearance. Manganese in large quantities gives a reddish to amethystine hue; and when the manganese is associated with 20 per cent CaO, and over, the slag very often has a resinous colour, closely resembling blende. Zinc in the presence of alumina, some manganese, and much silica (from 36 to 37 per cent) gives a colour very closely resembling porcelain or obsidian: this is especially true of the outer rim of the pot (see analysis, further on). Lustrous black slags are always due to the presence of much iron. Some exceedingly siliceous (38 to 42 per cent silica) have a greenish cast.

Lustre.—Most of the slags formed in lead smelting are vitreous, although the high lime and also the very high iron slags are not as a rule vitreous. The lustre is rarely pearly, often resinous; submetallic, splendent, also pitchy; in short, they possess lustres analogous to those of the unisilicates and bisilicates as formed in nature.

Fluidity.—Thick, viscid slags almost invariably occasion losses in both silver and lead; generally the more fluid a slag is the more perfect will be the separation of lead, and consequently that of the silver. When the fluidity is entirely dependent upon iron there is a liability to iron crusts, and these will then produce great losses. Scientific smelting should aim at obtaining a fluid slag, a slag built up to approach some one of the recognised types. Silica is the chief cause of viscidity in slags, although even a properly calculated slag will sometimes run viscid owing to a lack of fuel, or soon after starting up or "blowing in" a furnace. During heavy snows or rains, or in exceedingly cold weather, the slag may run viscid because of an insufficiency of fuel.

Manganese increases the fluidity of slags to a marked degree, often rendering even siliceous slags fluid. Lime may or may not make a fluid slag; most high lime slags flow with a smooth oily flow, fluid when hot and either stringy or brittle according to the other ingredients present. Some slags are so fluid and smelt so fast, especially when the ore charge is coarse, that they do not allow a perfect separation of lead and silver; under these circumstances the furnace is said to "drive too fast."

Fusibility.—Generally the more fusible slags are the more economical they are; they require less fuel, drive faster, often prevent "over fire," cause a more perfect separation of the valuable metals, and should be the aim of the lead smelter. Easily fusible slags do not always give rise to very bright tuyeres, although they usually show a light, and the scale or crust immediately in front of the tuyere is quite thin.

Silica lessens the fusibility; manganese and iron always increase it; while magnesia and zinc rarely, if ever, cause a more fusible slag. Alumina may or may not increase the fusibility of lead slags. If the percentage of silica is low alumina plays the *rôle* of an acid, and hence increases the fusibility; if, however, the percentage of silica be high, then alumina acts as a base, and hence lowers the fusing-point of slags. This statement has been arrived at after many long and extensive experiments, involving the smelting of many thousand tons of ore. The closer certain recognised slag types are approached, the greater will be not only the fluidity but also the fusibility. It is, however, not always an economical mode of procedure to adhere too rigidly to any general form of slag.

The subject of the fusibility of slags cannot but be regarded as one of the chief points to which the lead smelter should direct attention in the treatment of silver-bearing lead ores by means of the shaft furnace. Prof. Gordon, in his translation of Grüner's "Studies of Blast Furnace Phenomena," makes the following valuable remarks:—"There is, however, a considerable difference in the temperature required for the complete formation of different slags. According to Plattner's experiments, although the temperature of fusion of the slag itself, when formed, varies much less for different proportions of acid and bases, forming singulo-silicates, bisilicates, and trisilicates, the temperature at which slags are formed varies considerably. In general, singulo-silicates require a higher temperature for formation than bisilicates; and of singulo-silicates those of alumina form at 2400° C., magnesia form at 2200° to 2250° C., baryta form at 2100° to 2200° C., lime form at 2100° to 2150° C., iron and manganese form at 1789° to 1832° C.

"The silicates of oxides of manganese and iron (protoxide) differ very little from each other. The bi- and trisilicates of the different earths are formed at a lower temperature. Of the bisilicates those of baryta and lime form at 2100° C., baryta and alumina form at 2050° C., lime and magnesia form at 2000° C., lime and alumina form at 1918° to 1950° C.

"The temperature required for the formation of compound silicates from the earths composing them is very much higher than that at which slags which have been already fused can be melted. As the slags coming from smelting processes are seldom formed by fusing together these independent components, but more frequently from a mixture of silicates already formed, partly from the ores, &c., and generally of manifold combinations of the oxides of the earths, the temperature required for the formation of the new slag or compound silicates will lie between their point of fusion and the temperature which would be necessary to form this new slag from the simple substances.

"Refractory slags, which are always indications of faulty working of the furnace, arise either from insufficient temperature or from injudicious combination of the charges,—as when too much silica and too little of the bases, or the contrary, are present, or if among the bases there be an excess of alumina and magnesia. Such slags are recognised by their pasty nature, their earthy, half-fused appearance, and by the air-holes pervading them. On the other hand, the charge is a good combination when the slag flows out at a good consistency, as free from metal as possible, and when, for a given consumption of fuel, the maximum of ores can be used."

Dr. Percy, while objecting to the principle of Plattner's method, because it assumes that alloys of gold, silver, and platinum fuse at the mean temperature of the component parts, says we may accept his results as affording practical information of value. "The melting-points of metals and their alloys are fixed and unvarying, except under extraordinary conditions of pressure, and as they extend through a very wide range of temperature they may be conveniently employed in the determination and comparison of high temperatures." Plattner himself considered that he had only determined temperatures "correctly proportioned to each other, and not absolute thermometric limits."

In this connection it will be well to quote a few lines from Overman, which, while they are in the main correct, contain one or two statements which are subject to limitations and corrections when viewed from a lead smelter's standpoint. "If," says Overman, "a compound of lime and silex melts at 3000° C., that of protoxide of iron and silex at 2000°, and that of a silicate of oxide of lead at 1000°, the mean heat of the three, by which they melt when mixed together, is not—

$$\frac{3000^\circ + 2000^\circ + 1000^\circ}{3} = 2000^\circ,$$

as their various degrees indicate, but it may be only 1500°, and in this case even lower than that." The above statement is unquestionably correct. Then follows this remark:—"The greater the number of elements in a slag the more fusible it becomes; it is therefore of the utmost

importance, in all smelting operations, to multiply the kinds of ores: this produces fusible slags and fusible metals." In general, multiple bases do produce a more fusible slag than where only a few bases are present; but there are certain notable exceptions to this rule or law in the cases of zinc, alumina, and magnesia. No intelligent lead smelter would for a moment think of adding zinc simply that there might be a larger number of bases to enter the slag; nor would it be policy to add either alumina or magnesia. For some reason, not as yet very clearly understood, magnesia has been found to increase the silver losses to a remarkable extent. The latter portion of the above quoted passage, in regard to multiplying the different kinds of ores, is the proper mode of procedure, from other considerations aside from the simple fact of fusibility. Overman also says "Slags should be as fusible as the metal which is to be smelted with their assistance. If they are more refractory than the metal, the slag causes it to assume a heat by which more or less of it is evaporated." Since lead melts at or about 325° C., the probabilities are that very few lead slags have this low fusing-point.

While there are a number of substances which will make fluid slags, yet, owing to the cost and the difficulty of procuring them in large quantities, we must therefore of necessity use either iron, lime, or manganese. The proper and economical use of these bases, in localities where the ores to be smelted are highly siliceous (and this is generally the case), becomes a matter of either profit or loss in carrying on this industry. The problem, in other words, may be stated thus:—How shall we cause the largest amount of silica to be fluxed off into the slag, and at the same time use as little costly bases as possible, producing a fusible and clean slag?

Magnetism.—In December, 1879, it was discovered that the slags produced at the old works of the Grant Smelting Company were all magnetic: thinking that perhaps this might be peculiar to this kind of slag, 108 samples were collected, including specimens from all the furnaces of the different works at that place, and in every case the same property was observed. The entire mass of some slags was found to be attractable by the use of an ordinary horseshoe magnet. An attempt was made to discover some relation between the intensity of the magnetism and the lead and silver losses, but so far without obtaining altogether satisfactory results.

Experiments were instituted clearly demonstrating that this magnetic property was not due to fine particles of metallic iron mixed with slag. It was also noted that it was exceedingly rare to find an ore from this locality which is not in part attracted by the magnet, and, by panning or concentrating these ores, the black magnetic oxide of iron, (Fe_3O_4), so common in placer mines, will be found. It may therefore be said, as a partial explanation, that this magnetic sand passes into the slag, giving it this property. It is possible that the reducing power of these furnaces was imperfect, for example, due to a lack of fuel; but the smelters at this time were inclined to use more fuel than has since been found necessary for good work. An oxidation at the tuyeres may also give rise to this phenomenon, as, for example, by using too strong a blast. I have found that even siliceous slags are more or less magnetic; all lead slags containing from 25 to 55 per cent of ferrous oxide, and even high lime slags, also are magnetic; hence the chemical composition seems to have little or no effect upon the magnetic property of slags. Of course, if magnetic oxide of iron enters the slag *as such*, it implies necessarily a waste of precious flux: yet I am of the opinion that the magnetic property is due to (1) an unavoidable mixture of some ferric silicate; (2) to the ferrous silicate itself; and (3) in many cases to the presence of iron matte: this is especially true where very impure ores are treated and the production of matte is large. The mineral fayalite is a silicate of protoxide of iron, yet it is attractable by the magnet. I find that iron matte (Fe_2S) is always more or less magnetic, therefore a part of the magnetic property is often due to this cause.

The slags produced at all the prominent smelting works in this country show more or less a magnetic property, and samples of slag from many of the abandoned dumps have this same characteristic; therefore I am led to the conclusion that this is a general property of lead slags.

If it can be shown that the magnetism of lead slags is due to sesquioxide of iron, more than nine-tenths of all the analyses of lead slags are incorrect, as it is exceedingly rare to find a slag analysis in which sesquioxide of iron is reported.

Friability.—The friability or brittleness of slags is dependent upon the number, kind, and amount of the bases present. Generally the more siliceous a slag is the tougher it is, and the greater the amount of base the more brittle it is, though the latter statement is subject to certain limitations. Slags not containing over 33 to 34 per cent of silica are usually brittle; whenever the silica runs up to, say, 35 to 40 per cent, we have quite tough slags unless the slag has very little iron and a large amount of lime (say from 22 to 30 per cent). A slag containing 30 per cent SiO_2, 50 per cent FeO, and 3 to 8 per cent CaO, is not very brittle, yet the amount of base is large in comparison with the amount of acid present. Slags of the type 30 per cent SiO_2 + 40 per cent FeO + 20 per cent CaO are always brittle; so also are the slags containing 34 per cent SiO_2 + 34 per cent FeO + 24 per cent CaO.

As an example of tough slags analyses Nos. 18, 32, 36, 40, and 97 may be cited. The following analyses are examples of brittle slags:—Nos. 7, 13, 14, 45, 46, 55, 56, 57, 64, 65, 66, and 67. The most brittle slags I have ever seen are those numbered 64, 65, 66, and 67 in the table of analyses. Whenever the amount of matte produced is quite large it is often best to form a slag which is slightly tough, otherwise there will be difficulty in obtaining a close saving of the matte. If the ores contain much zinc this causes the matte cake to adhere closely to the bottom of the slag cone; in this case it is best not to have the slags too brittle. Generally the brittle slags are freer from both silver and lead. The brittleness is the result of a highly crystalline structure.

Influence of Slow and Rapid Cooling.—The more slowly a newly-drawn pot of slag is cooled, the more perfect will be the crystallisation. Such slowly cooled slags have a certain fixed fusing-point, and are generally only imperfectly soluble in any of the strong mineral acids. This slag, upon breaking open a pot ordinarily, shows a well-defined crystallisation when the type is closely approached, and on the outer edge there will be a thin crust or scale of glassy material. If slags are cooled rapidly the crystallisation will be imperfect, and if very rapidly the structure is entirely changed and often crystallisation is entirely absent. If melted slag is either poured or plunged into water the crystallisation is entirely prevented, and the mass (if not in too large quantities) will show a glassy appearance not unlike that of obsidian. Slags thus rapidly cooled have suffered a very remarkable and hitherto unrecorded change; they will be found to have a much lower fusing-point, and by powdering them they will be found to be entirely soluble in any of the strong acids, especially in hydrochloric acid. By taking advantage of the last-named fact it will be readily seen that fusions for the analysis of slags are entirely unnecessary in connection with this industry.

It is generally customary at lead smelting works to turn a stream of water on the slag trough or "slag runway" soon after tapping a pot of slag, thus chilling and rendering brittle that portion which has adhered to the trough; and this is most always thrown away, injudiciously so it is thought, since this portion will not only contain many matte globules, but also very often pellicles of lead which may have lodged upon the trough either from a "blow-pot" or from a leaky breast. This rapidly cooled slag is not only generally richer, therefore, than the main

body of the slag, but, if for no other reason, it should be saved for these uses: it melts at a very low temperature, and hence is valuable for "blowing-in" a furnace; to be fed after "barring the hangings"; and it also serves a most admirable purpose in keeping down or preventing the so-called "over fire" or "fire tops."

(To be continued.)

VALUATION OF INDIGOES.

An Investigation into the Various Methods Employed for the Estimation of Indigotin, together with certain New and Modified Processes.*

By CHRISTOPHER RAWSON, F.C.S.

Indigo was known in India and Egypt more than two thousand years ago, but was not introduced into Europe for dyeing purposes until the seventeenth century. Notwithstanding the countless numbers of colouring-matters which of late years have found their way into the market, indigo may still be considered the most important of all dyewares. It is not my intention, however, to speak of the dyeing properties of this valuable colouring-matter, nor of its mode of preparation; but I purpose to notice some of the most reliable methods for ascertaining its value.

As this drug varies in value from 1s. to 10s. per lb., it is of the utmost importance to the consumer that he or his chemist should be able (without the expenditure of much time or labour) to determine the exact composition, so far as its tinctorial power is concerned, of a sample of indigo under examination. Many indigo merchants, and others, who have had years of experience in the buying of indigoes, seem to imagine that it is quite possible to form a perfectly accurate estimate of the drug by mere inspection. I am inclined to think there are dyers who hold the same opinion, and who look upon the chemical examination of indigo and other dyewares with a considerable amount of distrust. Although I have often been surprised to find indigo dealers classify their samples with so much accuracy, yet repeated experiments have convinced me that frequently their estimates have been in error to the extent of 3d. to 9d. per lb.

The principal colouring-matter in indigo is indigotin, in addition to which indigo-red, indigo-brown, indigo-gluten, and mineral matter are present. The different shades obtained in the dye-bath by different classes of indigo are, for the most part, due to the relative proportions of indigotin and indigo-red present; the other bodies produce little or no effect. Anyone for the first time wishing to determine the amount of indigotin in a sample of indigo, would probably be bewildered by the numerous processes which he would find had been proposed for attaining that object; and upon consulting different text-books he would also discover that authorities differed very considerably in describing what may be said to be the same process. Many of the methods, copied from one book to another, with or without alteration, are utterly untrustworthy; while others, although fairly accurate, require so much time and attention that for commercial purposes they are out of the question.

In this paper I purpose making the following classification of the methods which I have examined:—

I. Where the indigo is dissolved by means of sulphuric acid.

II. Where the indigotin is estimated by means of sublimation.

III. Where the indigo is reduced to indigo-white in an alkaline solution.

1. *Solution in Sulphuric Acid.*—In the first place it is of course important that the sample taken for analysis should represent as nearly as possible the bulk from which it has been obtained. This is best performed by taking small pieces from each of the lumps in the sample and pounding them together in a mortar. After grinding a portion to an impalpable powder it is passed through a fine sieve, any any particles remaining are returned to the mortar, until the whole is fine enough to pass through the sieve. When carefully worked in this manner I have found, in the great majority of cases, the dock samples to agree remarkably closely with the chests of indigo represented.

Regarding the solubility of indigo in sulphuric acid, writers differ very greatly; not only in respect to temperature and time to which the mixture is to be exposed, but also as to the quantity and strength of acid to be employed. The following receipts for dissolving indigo (which I have copied from well-known text-books) show to what an extent this diversity of opinion prevails:—

(*a*) Digest 1 grm. indigo for some hours at a temperature of 50° to 60° with 10 grms. fuming sulphuric acid.

(*b*) Mix 1 grm. indigo with 12 grms. strongest fuming sulphuric acid; allow to stand for twenty-four hours at a temperature of 20° to 22°.

(*c*) Mix 1 part indigo with 5 parts ordinary sulphuric acid, and keep at a temperature of 40° for ten to twelve hours.

(*d*) Mix 1 part indigo with 20 parts sulphuric acid, and allow to stand twenty-four hours at 30°.

(*e*) Mix 1 part indigo with 15 parts strongest sulphuric acid, and allow to stand three days.

(*f*) For the purpose of dissolving indigo only the strongest fuming sulphuric acid (sp. gr. 1·89 to 1·92) is available.

I have made a number of experiments in order to determine the quickest and best method for rendering indigotin perfectly soluble in sulphuric acid, and have finally adopted the following mode of procedure:—

One grm. of finely powdered indigo is intimately mixed in a small mortar with its own weight of ground glass. The mixture is gradually and carefully added, during constant stirring with a glass rod, to 20 c.c. of concentrated sulphuric acid (sp. gr. 1·845) contained in a cylindrical porcelain crucible (cap. 1½ ozs.); the mortar is rinsed out with a little powdered glass, which is added to the contents of the crucible, and the whole is exposed in a steam oven for a period of one hour to a temperature of 90° C. The sulphindigotic acid thus formed is diluted with water, and made up to 1 litre.

By this mode of treatment experience has shown that all the indigotin is thoroughly dissolved, whilst the filtered solution obtained is freer from foreign bodies than when the methods previously quoted are employed. The following table contains a few of the results obtained in these experiments:—

Time during which the mixture of indigo and sulphuric acid was exposed.	Indigotin. Hyposulphite required by 50 c.c. ind. solution—c.c.	Percentage of Indigotin by Hyposulphite method. Java.	Kurpah.	Madras.
¾ hour at 90° C.	10·2	—	—	37·10
1 hour at 90° C.	10·25	68·50	46·75	37·35
2 hours at 90° C.	—	68·05	—	36·70
3 hours at 90° C.	—	—	—	35·60
24 hours at 15° C.	10·2	68·25	47·10	37·15

The solution of sulphindigotic acid must be filtered in order to separate certain insoluble impurities, which otherwise would interfere with subsequent operations. Pure indigo-blue dissolved in sulphuric acid is, by the action of various oxidising agents, more or less readily converted into a pale yellow body, named sulphisatic acid. The substances which have been most generally used for the purpose of analysis are chlorine, bichromate of potash, and permanganate of potash. Unfortunately all these bodies attack not only the indigotin, but act also

* *Journal of the Society of Dyers and Colourists*, No. 4, Vol. I.

upon the green and brown substances which are present to a greater or less extent in samples of commercial indigoes. When, therefore, an analysis is made by the employment of a standard solution of chlorine, bichromate of potash, or permanganate of potash, the result obtained is always too high, and, as a rule, the poorer the quality of indigo the greater will be the error, on account of the presence of larger quantities of other substances possessing no tinctorial power.

Of all the processes based upon oxidation I consider the "permanganate" method by far the best; and yet I know of no text-book which enters into any details respecting it. The use of bleaching-powder, chlorate of potash, and bichromate of potash requires the solution of indigo to be of such a strength that, in the case of inferior qualities, the end of the reaction is obscured by the dark colour of the liquid.

Many persons who are not well versed in chemical manipulation, or who cannot devote the time to a detailed analysis, may occasionally desire to determine the value of a sample of indigo. In such cases I would strongly recommend the "permanganate" process, in the manner to be now described. About 1 grm. (0·75 to 1·25) of the sample is dissolved in sulphuric acid, as previously stated, diluted to 1 litre, and filtered; 50 c.c. of the filtrate are measured into a porcelain dish, to which are added 250 c.c. of distilled water. To this diluted liquid a solution of permanganate of potash (0·5 grm. per litre) is gradually run in from a burette, until the liquid, which at first takes a greenish tint, changes to a light yellow. With indigotin and the better qualities of indigoes the end of the reaction is remarkably clear and distinct, and even with an inferior "Kurpah" containing much foreign matter it is easy, with a little practice, to obtain results agreeing very closely one with another. According to the equation—

$$5C_8H_5NOSO_3+K_2Mn_2O_8+3H_2SO_4= \\ =5C_8H_5NO_2SO_3+K_2SO_4+3H_2O+2MnSO_4,$$

1 molecule of potassium permanganate oxidises 5 molecules of sulphindigotic acid, and consequently 316 parts of potassium permanganate become the measure for 655 parts of indigotin. Although with a strong solution of indigotin the theoretical quantity of permanganate is decolourised, yet I have found, on working with a dilute solution, that the end of the titration is reached by the consumption of a smaller amount of potassium permanganate than is indicated by the above equation. In order to obtain comparative results it is necessary that the solution of indigo should be dilute, in which case the reaction which takes place is not strictly according to the above equation; therefore the strength of the "permanganate" solution should be ascertained by dissolving 0·5 grm. of pure indigotin in sulphuric acid, and treating the solution obtained as previously described. The results obtained by this method are somewhat too high, yet they give one a fairly approximate idea of the relative values of different samples under examination.

(To be continued).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, December 15th, 1887.

Mr. William Crookes, F.R.S., President, in the Chair.

(Concluded from p. 277).

99. "*Isomeric Change in the Naphthalene Series.*" No. 1. By Henry E. Armstrong.

It having been ascertained that betanaphthylsulphate, $C_{10}H_7{\cdot}OSO_3H$, may be converted by mere warming in the water-bath into the isomeric betanaphtholsulphonic acid (Schaefer's modification), the study of the conditions under which isomeric change occurs in the case of naphthalene-derivatives became of special importance in determining the laws which govern substitution in the naphthalene series, and indeed generally. Experiment soon showed that there were important differences to be observed: thus bromobetanaphthol gave but little sulphate, being almost entirely—and *apparently* directly—converted into the isomeric acid which may be prepared by brominating Schaefer's betanaphtholsulphonic acid; in like manner, betanaphthylsulphate when sulphonated by chlorosulphonic acid does not yield, as might have been expected, a sulphosulphate, but an isomeric disulphonic acid. This latter acid is of special interest on account of the readiness with which, by mere warming with dilute sulphuric acid, it is converted into Schaefer's betanaphtholmonosulphonic acid: there is little doubt that one of the sulphonic groups occupies an alpha-position contiguous to the OH, and hence the readiness with which it is displaced by hydrogen. These observations have not only led to the experiments being made of which the results are described in the following notes, but they have served in connexion with the observations on the sulphonation of naphthalene to favour the assumption that the action of sulphuric acid is in the majority of cases of a very simple character, and that when isomers are produced, their formation is very frequently the outcome of isomeric change. The author proposes to pay special attention to the investigation of this question, and not only in the naphthalene series.

100. "*Isomeric Change in the Naphthalene Series.* No. 2. *β-Ethoxynaphthalenesulphonic Acids.*" By E. G. Amphlett and Henry E. Armstrong.

In order to determine the course of chemical change when the formation of the sulphate is prevented, the authors have sulphonated by means of chlorosulphonic acid the ethoxynaphthalene, $C_{10}H_7{\cdot}OC_2H_5$, prepared by ethylating betanaphthol. The product obtained when a cold solution in carbon bisulphide is operated upon is a mixture of two sulphonic acids, one of which is undoubtedly derived from Schaefer's modification of betanaphtholsulphonic acid, and the other probably from Baeyer's modification; if the product be heated in the water-bath, the latter acid is converted by isomeric change into the former.

The two acids are readily distinguished by means of their barium salts: that of the former acid being almost insoluble in water, while that of the latter dissolves easily and crystallises in transparent prisms containing $3H_2O$. On submitting the difficultly soluble potassium salt from the former acid to the action of bromine, a difficultly soluble ethoxybromosulphonate is obtained; and on further treatment with bromine the bromhydroxyquinonesulphonate is produced which may be prepared in a similar manner from Schaefer's acid. Altogether different results are obtained on heating the isomeric ethoxyacid with bromine. Experiments are in progress with other derivatives of both α- and β-naphthol in which the hydroxylic hydrogen is displaced by positive and negative radicles.

101. "*Isomeric Change in the Naphthalene Series.* No. 3. *β-Chloronaphthalenesulphonic Acids.*" By Henry E. Armstrong and W. P. Wynne.

The authors have previously shown that when β-chloronaphthalene is sulphonated by means of chlorosulphonic acid, the product consists of the two isomeric monosulphonic acids which Arnell obtained by using fuming sulphuric acid: one of these is the $\beta^2\beta^{2'}$-derivative corresponding to Schaefer's betanaphtholsulphonic acid, and it was of importance to determine whether this acid was a primary product of sulphonation or a product of isomeric change. It is found that a small proportion—very few per cent—of the $\beta^2\beta^{2'}$ acid is formed even when the sulphonation is effected by adding the chlorosulphonic acid to a cold solution of β-chloronaphthalene in carbon

bisulphide, and that heating on a water-bath has little or no effect; but that if the product be heated to a temperature at which it is just fused—about 150°—for an hour, an appreciably larger proportion of the $\beta^2\beta^{3'}$ acid is obtained, and that after heating for five hours at 150° the product chiefly consists of this acid. There can be little doubt therefore that the $\beta^2\beta^{3'}$ acid is a product of isomeric change.

102. "*Isomeric Change in the Naphthalene Series.* No. 4. *α-Haloidnaphthalenesulphonic Acids.*" By Henry E. Armstrong and S. Williamson.

The authors have previously shown that when α-chloro-, or α-bromonaphthalene is sulphonated by means of chlorosulphonic acid the product mainly consists of the 1 : 4-derivative together with a very small proportion of what is probably the 1 : 2-derivative. They now find that if the product be heated at 150°, isomeric change takes place, new acids being formed of which the constitution has yet to be determined.

It has been stated by Gessner that when potassium α-bromonaphthalenesulphonate is heated with PCl_5 it is converted into a chloronaphthalenesulphobromide melting at 115°. The authors have obtained the normal product, bromonaphthalenesulphochloride, which melts at 101°; but on heating potassium chloronaphthalenesulphonate with PBr_5, they obtained a substance precisely like that described by Gessner and which gave similar results on analysis: this, however, they find is a mixture or compound of chloronaphthalenesulphobromide and bromonaphthalenesulphochloride, and they are inclined to attribute its formation to the presence of free bromine in the PBr_5, and that of Gessner's product to free chlorine in the PCl_5 used by him.

Jolin's statements regarding the properties of bromonaphthalenesulphonic acid, which do not accord with their own, are no longer surprising now that the occurrence of isomeric change on heating is established; the authors have moreover observed that when bromonaphthalene is heated with excess of sulphuric acid the bromine is displaced, a naphthalenedisulphonic acid being formed; it is not improbable that the dibromonaphthalene melting at about 160° which Jolin obtained was formed from a naphthalenedisulphonic acid.

103. "*The Sulphonation of Naphthalene.*" By Henry E. Armstrong and W. P. Wynne.

After a very careful study of the products of the direct sulphonation of naphthalene and of the naphthalene-monosulphonic acids by means of chlorosulphonic acid, the authors are convinced that the initial action is always of a simple character and takes place in accordance with what one of them has termed the alpha-law; and as they have also failed to obtain any evidence of the occurrence of isomeric change in the case of the sulphonic acids, they are of opinion that the formation of β-sulphonic acids is due to secondary change, and probably involves the formation and subsequent partial hydrolysis of a higher sulphonic acid than that which is eventually separated. Thus they find that naphthalene may be almost entirely converted into the α-monosulphonic acid by careful treatment with a single molecular proportion of chlorosulphonic acid, and that the sole product of the action of 2 mol. props. is the $\alpha'\alpha^{4'}$ or γ-disulphonic acid; the pure β-monosulphonic acid in like manner yields as sole product the β(?)-disulphonic acid previously described by them, which is undoubtedly an α-β-derivative—in all probability the 2 : 4′ modification. By heating naphthalene with a considerable excess of chlorosulphonic acid at about 150°, they have obtained a trisulphonic acid. This acid yields a very soluble lead salt. Its sodium salt crystallises in aggregates of very slender needles of the composition $C_{10}H_5(SO_3Na)_3 \cdot 5H_2O$; its sulpho-chloride melts at 194°. Experiments are in progress to determine the nature of the trisulphonic acids formed in a similar manner from the β (?) and Ebert and Merz's two disulphonic acids.

To determine whether the sulphonic acids undergo isomeric change, an aqueous solution of the β (?)-disulphonic acid was heated in an air current at a temperature gradually rising to 170—180°, at which it was maintained for several hours: much naphthalene sublimed, and the residue was found to consist almost entirely of the β-monosulphonic acid. Ebert's and Merz's α-disulphonic acid treated similarly underwent no change. On evaporating the water from a solution of α-monosulphonic acid as far as possible at 100° and then raising the temperature to 115°, hydrolysis immediately sets in.

NOTICES OF BOOKS.

Sewage Treatment, Purification, and Irrigation. A Practical Manual for the use of Corporations, Local Boards, Medical Officers of Health, Inspectors of Nuisances, Chemists, Manufacturers, Riparian Owners, Engineers, and Ratepayers. By J. W. Slater, F.E.S. London: Whittaker and Co., and G. Bell and Sons.

We have had a sufficiency—or something more—of patents for dealing with sewage, of reports, papers, and acrimonious discussions on this vexed and fertile subject. Now, by way of variety, we have a practical, sober manual for treating this troublesome waste product of human life. The author—a man of long and wide experience—has, we must admit, no *system*. There is no one process which he recommends as universally applicable. His preference is evidently awarded to "precipitation *plus* absorption," that is the use of a suitable metallic precipitant in conjunction with some absorbing or occluding agent, such as clay, earth, carbonaceous matters, &c. This process, he shows, involves "inverse irrigation," as by it the sewage is not passed through the land, but the land, or its equivalent, through the sewage. Irrigation he considers an excellent method of disposing of and utilising sewage where the conditions are favourable, but he is not blind to its defects, and condemns the "attempt to represent it as the only means of dealing with the sewage difficulty." It is liable to encourage dipterous insects, which, on the evidence of Grassi, Daraine, Manson, Maddox, and others, the author shows to be agents, perhaps *the* agents, in the diffusion of zymotic disease.

A strong point in favour of irrigation from the economical point of view is here brought forward—the successful conversion of Italian rye-grass into hay.

The Bazalgette system and the scheme for deodorising sewage without previous precipitation or irrigation are condemned. Perhaps the author would have expressed himself more forcibly on the latter scheme had he met with the recent report of the Medical Officer of Health for the Port of London. This gentleman, whose duties must involve a thorough acquaintance with the condition of the river, declares that during last summer its state between Greenwich and Erith was abominable, amost beyond description.

Filtration as a substantive process the author considers applicable only if the sewage contains matter injurious to crops and to the land, a state of things, we must add, by no means uncommon in our own great manufacturing towns.

Among precipitation processes he disapproves of all in which lime figures, not merely for neutralising possible acids, but as a substantive agent, thus rendering the effluent water alkaline. He utterly rejects salts of tin, lead, zinc, and barium. He gives the preference to salts aluminium, especially the basic sulphates and the chloride, to soluble aluminates, and silicates. The practical instructions for conducting precipitation, for arranging tanks, for judging of the degree of purification effected, &c., show close observation, and will prove exceedingly useful.

Under "Promiscuous Methods" we find mention of the "Metropolitan System," in which sewage is first to

be slightly precipitated with lime and copperas, the effluent then deodorised with sodium permanganate and sulphuric acid, then aërated, and the deposit lastly put on board ship and sunk in the North Sea. This process, the author tells us, is like Dr. Abernethy's celebrated receipt for dressing cucumbers, and he reminds us that here "the entire expenditure is incurred in pure waste, no value being recovered from the sewage."

For Royal Commissioners the author does not entertain any profound respect, considering that they are prone to ignore any evidence which does not seem likely to support their own prepossessions. As a matter of course, the "Recommendations" of the late "Royal Rivers Pollution Commission" are weighed and pronounced wanting on grounds substantially agreeing with those which have been urged from time to time in the Chemical News. He points out especially the very easy manner in which all restrictions may be evaded which are founded merely on the quality of waters discharged into a river without regard to their quantity.

As regards sewage legislation, he points out two glaring defects in the Act of 1876, now in force, and in the Bill brought in by Earl Percy, Col. Walrond, and Mr. Hastings. These defects are that neither of the measures attempted a codification of the law on the pollution of rivers, and that they provided no remedy for the contamination of underground waters.

To persons who are candidly seeking the solution of the sewage question, this book will be welcome and useful. But there are, we fear, quarters in which it will meet with a very hostile reception.

Foods: Their Composition and Analysis. A Manual for the use of Analytical Chemists and Others. With an Introductory Essay on the History of Adulterations. By A. Wynter Blyth, M.R.C.S., F.C.S., &c. Third Edition. London: C. Griffin and Co.

We have here an encyclopœdia of adulterations and the methods for their detection on a level with the requirements of the day. From Accum's "Death in the Pot," and even from the "Report of the *Lancet* Analytical Commission" to the work before us, there is indeed a change for the better. Vague, hearsay statements as to prevalent sophistications have given place to precise information, based upon actual determinations. Doubtful analytical methods have been set aside, and in their place have come more trustworthy procedures. Meantime the enemy has not been standing idle. New frauds have been devised as old tricks became exposed, and it would be idle to say that the difficulties of detection have not in some cases been increased.

The introductory portion of the work is exceedingly valuable. It gives an account of the existing state of the law on adulteration, with abstracts of cases and judicial systems. We regret that we find here no notice of the ultimate result of the case where a town councillor added a poison to a sample after purchase, but before sending it to the borough analyst. As to the thorough amendment which the statutes bearing on adulteration require, we fear it is, under the English system of "government by party," out of the question.

The work before us, however, is by no means limited to the consideration of frauds. The author, for instance, treats at length on the analysis of water, the undesirable matters often found in which are certainly not due to the intentional addition of any substance whatever. Milk and cheese may be rendered dangerous by disease, improper diet, or by subsequent decompositions. On this subject we find a passage in which we cannot agree with Mr. Wynter Blyth's reasoning. He writes:—"Mr. A. H. Smee has also stated that the milk of cows fed on sewage (irrigation) farms rapidly putrefies, but no details are given as to the manner in which the samples were collected, and the explanation may be that the putridity of the milk was not due to the grass eaten, but that the teats of the cow were fouled by decomposing substances which would mix with the milk and infect it." We cannot accept this explanation. Mr. A. H. Smee's experiments were comparative: one cow was fed on sewage-grass and one on normal grass, the diet of the two being afterwards reversed. In the absence of direct evidence to the contrary, we are bound to assume that both cows were milked with the same precaution or want of precaution. It cannot be supposed that in every case the cow fed on sewage grass had her teats fouled whilst those of the other fed on normal grass remained clean! Even if we suppose that the cow feeding on sewage grass had the opportunity of fouling her teats with her food (which by no means follows) the sewage grass is not exculpated, since we may be sure that at an irrigation farm the teats of the cows will not be carefully washed and disinfected before milking.

As regards the analysis of milk, the author states that, though some partial modifications have been introduced, the general process is still that of Mr. Wanklyn. Among the modifications is the determination of fat. According to the method proposed by Dr. Adams, this constituent comes out about 0·5 per cent higher than by the Wanklyn process. This, of course, brings the total quantity of "solids not fat" proportionately lower. "Milk sugar," we read, "so far as is known, is only found in human milk, the milk of the herbivora, and of the bitch." This statement does not agree with the analysis of the milk of the sow, which, according to Kœnig, contains, as given below, 3·13 per cent of sugar.

The part played by milk in the distribution of scarlet fever is admitted as established. The alleged adulteration of milk with the brains of horses is rightly set aside as mythological. The addition of antiseptics to milk is condemned. They can have no effect in destroying the germs of any disease communicable to man, and by their use cleanliness in the dairy would not be regarded so essential as it is at present.

It appears that arsenical washes have been applied to the rind of cheese to prevent the attacks of flies, and in a few cases—one so late as 1854—arsenic has been mixed with the cheese itself as a preservative.

In speaking of sugar the author gives no indications for discriminating beet-sugar from cane-sugar. Bees can distinguish them, and we hear practical men in the sugar trade who can do the same, however the samples may be refined.

In discussing water the author remarks that, "in England, although foxes may be dug out to be eaten alive by hounds, and rat-catchers may poison rats by the gross, scientific men are unable, save under practically prohibitory restrictions, to advance biological science by the use of life itself as a reagent for obscure poisons." He scarcely brings into view the full inconsistency and absurdity of the law. A man may poison wild animals in any number to get rid of them, or simply for amusement, or for a wager. But the moment he seeks to derive any instruction from their death he is liable to fine and imprisonment.

To call attention to everything in this closely-printed volume which might justify notice—for the most part of an approving character—is plainly beyond our power. So we must content ourselves with pronouncing it a storehouse of valuable information and trustworthy guide for the analyst in a very difficult and onerous department of his profession.

A Manual of the Manufacture of Gas from Tar, Oil, and other Liquid Hydrocarbons, and Extracting Oil from Sewage Sludge. By W. Burns, C.E. London and New York: E. and F. N. Spon.

From the preface to this book and from certain passages which we meet with here and there, the author seems to have had what in America would be called a "difficulty"

with the *Journal of Gaslighting*. Into the details of this grievance we cannot enter, from the sufficient reason that, save from the passages which Mr. Burns quotes, we do not know what the *Journal of Gaslighting* has said. An apparatus is here described as capable of producing 14-candle gas at 2d. per thousand, "perfectly free from sulphur and ammonia impurities." The raw material is tar. We find it stated that "a mixture of coal and wood tar gives a larger proportion of essential vapour than either of these tars does when distilled alone, and . . . when coal and wood tar is mixed with animal oil and distilled by the method above described it will produce a superior illuminating gas."

It is, of course, impossible to test these statements except by practical working on a fair scale. But if Mr. Burns can really produce such gas as he described at 2d. per 1000, we should think that he will not need to wait long for the opportunity of making good his claims.

The "Cumulative Piston Retort," an apparatus here described and figured, seems applicable to a number of important purposes. The author enumerates the manufacture of coke, the tar and ammonia being likewise utilised; the distillation of sawdust, peat, &c., for the production of tar and acetic acid; the treatment of pyrites, either for obtaining sublimed sulphur or for the manufacture of sulphuric acid; the distillation of lime and cement; the production of salt-cake and hydrochloric acid (the first stage of the Leblanc alkali process), and the conversion of the salt-cake into black-ash. Here it is said that the ordinary mixture of salt-cake, limestone, and ground coal, if furnaced in these retorts, instead of producing calcium sulphide, as in the reverberatories, sulphuretted hydrogen is generated, from which it is proposed to recover the sulphur.

Another suggested application is the extraction of oil from the press-cake of olives.

Concening all these processes, we can only repeat what we have in substance already remarked, that if the "cumulative piston retort" can do any of these things better than they are done already, it has a great future. But here experience alone can decide.

Meantime we cannot accept the statement of Mr. Burns, that the utilisation of sewage sludge is a problem not yet solved, and that all the schemes to convert it into a portable manure have failed. A manure containing nitrogen equal to 3 per cent of ammonia, and phosphoric acid equal to 5 per cent of tricalcic phosphate, and which in practice gives better results than its analytical composition would lead farmers to expect, cannot be called unsatisfactory.

Nor is the drying of the sludge necessarily attended with "ruinous expense." When it is spread out in thin layers it dries, not so much, as Mr. Burns thinks, by evaportion from the surface, as by absorption downwards and laterally, if the soil is suitable.

The Students' Hand Book of Chemistry, with Tables and Chemical Calculations. By H. Leicester Greville, F.C.S., F.I.C. Second Edition. Edinburgh: E. and S. Livingstone.

The rush of elementary treatises on chemistry, which has for some time subsided, seems to be again on the increase. A friend ot ours asks if, like seasons of bad trade, political excitement, and epidemics, the appearance of such books might not be brought in connection with the periodicity of sun-spots? The work before us, however, may claim some very decided merits. In the first place, it contains no reference to examinations and no collection of papers set by any degree-granting body. We may venture to say that the author's primary object is to enable the student not so much to "pass" as to "know." His account of the periodic law is sound, and, giving honour where honour is due, he recognises Mr. Newlands as the initiator of the system which Mendeleeff and Meyer have since further developed. He has appended to his treatise a very useful glossary or collection of definitions of the principal terms used in chemistry.

On the other hand we must notice a peculiar and scarcely justifiable classification of the elements into "non-metals, metalloids, and metals." Here the term metalloid is used, not as it is often done, *e.g.*, by French chemists for the non-metallic elements, but for some simple bodies, "which from physically resembling metals while chemically they have greater analogy to the non-metals, occupy a sort of border line between the two classes." This, we submit, is likely to occasion confusion.

In the theoretical chapters of the book we find no reference to thermo-chemistry, a subject which in these days cannot justly be overlooked.

The aniline colours occupy but little space, and we are surprised to find *mauve* spoken of as a "commercial colour" and as "one of the most important aniline dyes." Surely the author must be well aware that the importance of this substance is purely historical, and that it has disappeared from the market. We also regret to find the alien word "fuchsine" given as a name for the rosaniline reds.

Taken as a whole, however, the work before us must decidedly rank among the preferable class of chemical manuals.

A few errors, clerical or typographical, deserve notice. We read here of "mythyl," "ormipent," "baisicity," and we find a promiscuous use of such orthographies as gelatin and gelatine, sulphocyanate and sulphocyanide.

Genealogical Tree of Coal-tar Products. By B. Vickers, F.C.S. Published by Bemrose and Sons, London and Derby, for Messrs. Lawton and Co., of Birmingham and Bradford.

We have here an original publication. The coal-tar products are shown in the form of a genealogical tree. The trunk of the tree is, of course, coal-tar. The branches shooting out to the right in ascending order are: Ammonical gas-liquor, carbolic oils, with some naphthalene, and heavy oils, the main twig of the latter being, of course, anthracene. To the left hand shoot out two mighty boughs; first runnings and light oils, and higher up creosote oils and naphthalene. All the sprays representing tinctorial compounds are coloured blue, green, red, yellow, &c., as the case may be. We think that this graphic representation of the connection and descent, so to speak, of the coal-tar products will prove a boon at once to teachers and students.

CORRESPONDENCE.

ANALYSES OF MIXED PAINTS.

To the Editor of the Chemical News.

Sir,—The answer to "R. S." on the analysis of mixed paints give by Mr. Thomas T. P. Bruce Warren if acted upon is likely to cause serious errors in such analyses. Paints containing metallic compounds, *i.e.*, oxides, carbonates, sulphides, and hydrates, when ground in linseed oil, undergo decomposition, oxyoleates of the metal being formed.

These oxyoleates are readily soluble in the solvents mentioned by Mr. Warren. Oil therefore extracted by his process would appear much above the truth, and the metal contained in the paint free from "oil" would be correspondingly low. Of course if the oil extracted with disulphide be burnt off, the metal will be left, and may be determined. But Mr. Warren objects to burning the oil.

Mixed paints, extracted in the same way, would give the same errors. In addition, Mr. Thomas T. P. Bruce Warren makes it appear that the oil and turpentine, shale

spirit, or petroleum, may be extracted with disulphide or with *petroleum spirit*, the sovlent then evaporated, the weight of linseed oil, boiled oil, resinous matter, &c., turpentine, *shale spirit* or *petroleum* is obtained! It is obvious that the turpentine, shale spirit, or petroleum would evaporate with the solvent used for their extraction, leaving nothing but the error introduced by precipitating the oil by means of chloride of sulphur to represent them.

Mr. Thomas T. P. Bruce Warren also states that "resin if present may be extracted by alcohol from the *matter removed by disulphide. Alcoholic solution of soda* in some cases is necessary for this purpose." An alcoholic solution of soda would certainly remove oil as well as resin.

The oil is not the "body" giving material of paints, the "body" being in the pigment. No amount of oil and turpentine added to sulphate of barium, for instance, would give it a "body."

I find that in making analyses of mixed paints it is best to decompose right off with nitric and hydrochloric acid, or with nitric alone when circumstances render the use of hydrochloric undesirable, taking the acid almost to dryness. This decomposes all the metallic soaps in the paint. The acid solution is filtered when the oil is retained on the filter with any insoluble matter, and is readily burnt off.

If an examination of the oil is desired, some of the paint is shaken up with ether, allowed to settle, the ethereal solution run off and evaporated, when the nature of the residue may be examined.

Petroleum or turpentine in mixed paints should be separated by distillation, and the oil in all cases be determined "by difference."—I am, &c.,

William Fox.

Laboratory, 4, Great Tower Street, E.C.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cv., No. 23, December 5, 1887.

The Expansion of Compressed Liquids, and in particular the Expansion of Water.—E. H. Amagat.—The author has studied, between 0° and 50° and from the normal pressure up to 3000 atmospheres, the compressibility and the expansion of water, common ether, the methylic, ethylic, propylic, and allylic alcohols, acetone, ethyl chloride, bromide, and iodide, carbon disulphide, and phosphorus chloride. Setting aside water the coefficient of expansion of other liquors decreases as the pressure augments. This decrease is less and less marked, but at 3000 atmospheres it is still very distinct. Under the normal pressure the coefficient augments with temperature; this variation also decreases progressively as the pressure increases. The coefficient of water increases at first very rapidly with the pressure; this increase goes on decreasing, and disappears about 2500 atmospheres.

A New Method of Determining Carbonic Acid in Solution.—Leo Vignon.—The coloured liquid produced by mixing 50 c.c. of lime water and 10 drops of a saturated solution of pure phenolphthalein is very rapidly decolourised by the addition of a sufficient quantity of an aqueous solution of carbonic acid free or combined with neutral calcium carbonate. Hence it results that carbonic acid in a free or a semi-combined state may be determined volumetrically by saturation with a standard solution of calcium hydroxide, using phenol-phthalein as indicator.

Justig Liebig's Annalen der Chemie. Vol. ccxxxix., Part 3.

Communications from the Chemical and Pharmaceutical Laboratory of the Technical High School at Brunswick.—Comprise papers by R. Otto on β-dichlorpropionic acid and by the same author on the synthesis of xeronic acid from α-dibrom normal butyric acid.

Contributions from the Chemical Institute of the University of Bonn.—These include a memoir on antimony pentachloride, by R. Anschütz and N. P. Evans; on the action of phosphorus pentachloride upon chloralide, by R. Anschütz and N. P. Haslam; the action of phosphorus trichloride upon salicylic acid and phenol, by R. Anschütz and W. O. Emery; the action of phosphorus pentachloride upon salicylic acid, by R. Anschütz and G. D. Moore, and the action of phosphorus pentachloride upon meta- and para-oxybenzoic acids, by the same authors.

The Colour-Bases from Furfurol.—Hugo Schiff.—In this second treatise is described β-furonaphthyline, the furopolyamines, dimethyl-furaniline, the furfurol bases with mixed amines, the furfuramidic acids, furopicramic acid, the constitution of the chromogenous furfurol bases. He then gives an account of experiments with furfur-alcohol, the behaviour of furfurol with phosphorus chloride, and the reactions of furfurol. In an appendix are described the derivative bases of cinnamic aldehyd.

Constitution of Propio-propionic Ether.—A. Geuther.—This ether is distinguished from acet-acetic ether by the fact that when mixed with sodium alcoholate and treated with ethyl iodide it yields, not ethyl propio-propionic ether, but propionic ether and ethyl-propionic ether.

Revue Universelle des Mines et de la Metallurgie. Vol. xxii., No. 1, July and August, 1887.

New Volumetric Process for Determining the Grey Zinc Powder of Vieille Montagne.—F. Weil.—On treating a given quantity of zinc-powder with an excess of a neutralised solution of copper, of a known strength, the metallic zinc contained in the sample precipitates copper, equivalent for equivalent. On then titrating the excess of copper remaining in solution with stannous chloride the difference between this quantity and the total copper employed indicates the copper precipitated by the zinc. If this amount is then multiplied by 1·0236, we have the quantity of pure zinc contained in the sample.

Process for Increasing the Value of the Phosphoric Acid in Thomas and Gilchrist Slags.—H. Bya.—L. Blum has patented a process for obtaining soluble phosphate by substituting soda for the lime used in the flux.

Bulletin de la Société d'Encouragement. Series 4, Vol. ii., No. 20, August, 1887.

Report presented by M. Le Chatelier on Behalf of the Committee of Chemical Arts on a Novel Alloy of Aluminium submitted by M. Bourbouze.—The alloy consists of aluminium and tin. If there is only 10 per cent of the latter metal the product is capable of being soldered whilst it retains the useful properties of pure aluminium.

On Beer-Yeast.—E. Ch. Hansen.—This lecture requires the accompanying illustration.

No. 22, October, 1887.

New Method for Distinguishing Animal from Vegetable Fibres.—The reaction utilised is that of α-naphthol with sugars or carbohydrates in general in presence of sulphuric acid, when an intense violet colouration is obtained, or, on dilution with water, a violet precipitate. The following is the most convenient process:—

0·01 grm. of the fibres, previously well-boiled in water to remove dressings, &c., is placed in a test-tube with 1 c.c. of water. Two drops of an alcoholic solution of α-naphthol at 15 to 20 per cent are then added, and a quantity of concentrated sulphuric acid equal in volume to the entire liquid. If the fibre is of a vegetable nature the liquid takes, on stirring, a deep violet colour, and the fibre dissolves completely. If the fibre is of animal origin the liquid takes a yellow or reddish-brown tint, more or less decided. If thymol is used instead of naphthol the colour is scarlet, passing into carmine on dilution with water.

Journal fur Praktische Chemie.
New Series, Vol. xxxv., Part 10.

Contributions to a Knowledge of the Aromatic Ketones.—Karl Ebs.—In this second communication the author examines benzophenone, tolyl-phenyl-ketone, ditolyl-ketone, ortho-xylyl-phenyl-ketone, the corresponding meta- and para-compounds, dipara-xylyl-ketone, mesityl-phenyl-ketone, pseudo-cumyl-phenyl-ketone, paracymyl-phenyl-ketone, α-naphthyl-phenyl-ketone.

Behaviour of Oxalic Ether with Resorcine. — Arthur Michael. — The author examines whether the similarity between sodium acetacetic ether and mixtures of other ethers (which do not form sodium derivatives) with sodium ethylate will appear also in its behaviour with phenols, and to this end he has made experiments with oxalic ether and resorcine.

MISCELLANEOUS.

Compressibility of the Watery Solution of Ethylamine.—F. Isambert.—Ethylamine in a watery solution behaves like ammonia; the coefficient of compressibility of this liquid decreases rapidly in consequence of the addition of water, so as to become lower than that of water. Here, as in the case of ammonia, but in a more decided degree, there is a formation, not of mere mixtures, but of true chemical combinations.—*Comptes Rendus*, Vol. cv., No. 24.

Detection of Aldehyds in the Alcohols of Commerce.—U. Gayon.—The author uses a well-known reaction, the rose-violet colouration given by the aldehyds and acetones in a solution of magenta previously decolourised by means of sulphurous acid. The reagent is prepared by mixing in succession—

Aqueous solution of magenta at 1-10th per cent	1000 c.c.
Sodium bisulphite at 30° B.	20 ,,
Hydrochloric acid, pure and strong ..	10 ,,

The bisulphite is passed into the solution of magenta, and then in about an hour the hydrochloric acid is added. The liquid is preserved in well-stoppered bottles. To make the assay the sample is let down with distilled water to about 50 per cent, and 2 c.c. of this dilute alcohol are then mixed in a test-tube with 1 c.c. of the reagent. The whole is shaken up and allowed to stand. If the alcohol is free from aldehyds the mixture remains colourless. Otherwise it turns a rose-violet, the deeper in proportion as the quantity of aldehyd is greater.—*Comptes Rendus*, Vol. cv., No. 24.

NOTES AND QUERIES.

*** Our Notes and Queries column waa opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices aa should legitimately come in theadvertising columns.

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Bell Scholarship.—I shall esteem it a great favour if you will let me know what subjects (ordinary and principal) have to be atudied in order to acquire a Bell Scholarship in chemistry, and of whom I could procure printed instructions, for a youth's guidance.—Inquirer.

To Remove Stains of Printing Ink.—Place a thick pad of white blotting-paper beneath the sheet of paper which is thus soiled. Then apply sulphuric ether (methylated will be the cheapest) with cotton-wool, gently rubbing. Then apply white blotting-paper to absorb the colour. Apply fresh ether, and repeat until all stains disappear. Do this away from a light.—G. A. Keyworth.

MEETINGS FOR THE WEEK.

Monday, 9th.—Medical, 8.30.
Tuesday, 10th.—Institution of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.30.
—— Photographic, 8.
Wednesday, 11th.—Geological, 8.
—— Microscopical, 8.
Thursday, 12th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— Mathematical, 8.
—— Telegraphic Engineers, 8.
Friday, 13th.—Quekett Club, 8.
—— Astronomical, 8.

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BOROUGH OF BIRMINGHAM.
GAS DEPARTMENT.

The Gas Committee of the Corporation of BIRMINGHAM are prepared to receive Tenders for the Tar to be produced at their various Works from the 30th of June next, for a period of one or two years, or for one year and then subject to termination of the contract on three months' notice on either side.

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Forms and Conditions of Tender may be obtained on application to me,

EDWIN SMITH, Secretary.

Borough Gas Office, Council House,
Birmingham, December 31, 1887.

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Telegrams, "Firebrick," Leeds.

London: Printed and Published for the Proprietor by EDWIN JOHN DAVEY, at the Office Boy Court, Ludgate Hill, E.C. January 6, 1888.

THE CHEMICAL NEWS.

Vol. LVII No. 1468.

EXTENSION OF TIME OF CULTURE IN Dr. R. KOCH'S BACTERIOLOGICAL WATER-TEST BY PARTIAL STERILISATION, WITH SPECIAL REFERENCE TO THE METROPOLITAN WATER-SUPPLY.

By GUSTAV BISCHOF, F.C.S., F.I.C.

The author points out that a source of error in Dr. Koch's biological water-test is due to the interference of certain colonies (those capable of liquefying gelatin) with the culture of other colonies. This interference is the chief obstacle which limits cultures to three days. To render an extension of time possible he endeavours to check the encroaching colonies by means of antiseptics. This he has effected by the use of spongy iron and of permanganate. He raises certain unsolved questions, showing that some microbia require weeks for their development, or may be incapable of growing in gelatin-peptone. He thinks it impossible to decide after three days' culture that no hurtful microphytes are present. He infers from his experiments that no bacteriological water-test can satisfy the demands of hygiene unless it is qualitative, distinguishing between harmless and pathogenic microbia. But no such test is at present known. Without such distinction merely numerical results are of little value. A small portion only of the colonies capable of growing in gelatin peptone is indicated by three days' culture. The ratio of colonies thus indicated by three days' culture to that of the total present appears to differ so widely in different samples that the number of colonies obtained from them cannot be compared with each other. Extension of culture beyond three days increases the reliability of the results, but how far this holds good and how far culture should be prolonged we have at present not sufficient evidence to decide.

These views will, we believe, meet with very general approval among chemists, who are concerned in the examination of potable waters.

METHOD FOR THE VOLUMETRIC DETERMINATION OF SOLUBLE PHOSPHORIC ACID IN SUPERPHOSPHATES.

By A. EMMERLING.

If we add soda-lye to a solution of superphosphate previously mixed with an excess of calcium chloride, the phosphoric acid is almost entirely precipitated as tricalcium phosphate, one molecule P_2O_5 requiring 4 mols. NaOH.

In this manner the amount of phosphoric acid in aqueous solutions of superphosphate may be determined by titration with soda-lye, but the free phosphoric acid present must be ascertained by a further experiment. This is effected by titrating the superphosphate solution with soda-lye, employing methyl-orange as indicator. This method has the advantage that the change of colour from violet-red to yellow or orange-yellow takes place at the instant when the free phosphoric acid passes into sodium monophosphate. If, then, the c.c. of soda-lye used in this titration are deducted from those consumed in the former experiment, a figure is obtained from which the amount of soluble phosphoric acid in the superphosphate can be calculated according to the proportion 4 mols. NaOH to 1 mol. P_2O_5.

Emmerling allows the solution of superphosphate, mixed with calcium chloride, to flow into a given quantity of soda-lye coloured with phenol-phthalein, and takes the disappearance of the colour as the end of the reaction.

The following solutions are requisite:—

1. A soda-lye of which 1 c.c. indicates about 0·005 grm. P_2O_5 calculated according to the above proportion. The standardising of the soda-lye is effected simply by titration with normal acid, using the same quantity of solution of phenol-phthalein solution (2 c.c.) which serves for titrating the phosphoric acid. Or the soda-lye may be standardised by a faintly acid solution of calcium monophosphate of known value.

2. A calcium chloride solution prepared by dissolving 200 grms. pure dry calcium chloride in 1 litre water. The solution reacts faintly acid, and must be carefully neutralised before use. This is best effected by titrating 100 c.c. of the solution with normal acid and neutralising the remaining 900 c.c. accordingly.

3. Phenol-phthalein, 1 part dissolved in 500 parts of alcohol, as indicator.

4. Methyl orange as indicator. A small quantity is dissolved in water until the quantity appears of a deep orange-yellow and the solution is then filtered.

The execution of an analysis is as follows:—

200 c.c. of the solution of the sample prepared in the ordinary manner are mixed with 50 c.c. solution of calcium chloride and well mixed. One burette is filled with this mixed solution and a second with soda-lye. Of this latter 20, 10, or 5 c.c. (according to the strength of the superphosphate) are measured into a beaker; 2 c.c. of the phenol-phthalein solution are added, and some water and superphosphate solution is then run in rather rapidly. As soon as the colour begins to grow faint the superphosphate liquor is added more gradually, and at last drop by drop, until the redness has entirely disappeared. The recognition of the concluding point, however, requires some experience. As it is necessary to use a large quantity of the indicator the change of colour is not instantaneous, and the reaction is not complete until the last trace of a reddish tone has entirely disappeared, and there appears in its stead a whitish, faintly brown, or yellowish colouration. A re-appearance of redness need not be regarded unless it ensues very quickly and decidedly. Frothing renders the recognition of the change more difficult, whence it should be avoided as far as possible. The determination should then be repeated, advancing more rapidly towards the point of saturation.

He next measures off again the same number of c.c. of the mixed solution of superphosphate and calcium chloride as used above, dilutes with a little water and mixes with 4 to 6 drops of the methyl-orange solution, so that a distinct violet-red colour is produced by the free acid. The liquid is titrated cautiously with the soda-lye, finally drop by drop until the reddish colour changes to a yellow or orange-yellow. Here also the recognition of the final point requires a little practice; the change is more distinct if the liquid has a moderate colouration. After this experiment also has been repeated the smaller number of c.c. of soda-lye, as consumed in the titration with methyl-orange, is deducted from the number obtained on titrating with phenol-phthalein. Thus is obtained the quantity of soda-lye requisite for precipitating the phosphoric acid as tricalcium phosphate. If we have dissolved 20 grms. superphosphate in 1000 c.c. of water and made up 200 c.c. to 250 by the addition of 50 c.c. of the calcium chloride solution, and if a is the measured quantity of soda-lye, b the solution of superphosphate and calcium chloride consumed, c the soda-lye used for neutralising the free acid, and t the standard of the soda-lye expressed as P_2O_5, the percentage of soluble phosphoric acid in the sample is—

$$= (a-c) \times t \times \frac{250 \times 1000 \times 100}{200 \times b\,20}$$

The method is applicable to ferruginous superphosphates.—*Zeitschrift fur Analytische Chemie* (vol. xxvi., p. 244).

DETECTION AND ESTIMATION OF SELENIUM IN METEORIC IRON.

By H. N. WARREN, Research Analyst.

T ollowing is an outline of the analysis of several specimens of meteoric iron which have been lately brought before my notice, and which, during the course of analysis, were all more or less found to contain small quantities of selenium associated with the iron, the separation of which was effected as follows:—

By reducing 10 grms. of the specimen to a rough powder by filing and intimately mixing it with pure flour of sulphur in sufficiency, the whole being introduced into a stout piece of combustion tubing, and heated to redness. One end of the tube is in connection with an apparatus evolving oxygen gas, for the purpose of burning off the sulphur, forming sulphurous anhydride, and expelling with it the small quantity of selenious anhydride formed at the same time by the combustion of the selenium present; the further end is connected with a series of bulb tubes containing distilled water to collect the reduced selenium formed by the action of the sulphurous acid produced. The solution containing the precipitated selenium is next heated to a temperature of 80° F. to render it more dense, introduced into a platinum dish, dried in the air-bath and weighed (a blank estimation being in each case determined with the sulphur employed). T he: ollowing is a tabulated view of the meteoric iron when separated from the matrix; *A*, *B*, from Bohumilitz; *C* Pallus iron; *D*, Elbogen; *E*, *F*, Atacama Desert.

A.

Iron	90·10
Nickel	6·54
Cobalt	0·24
Copper	—
Manganese	0·12
Selenium	0·23

B.

Iron	94·51
Nickel	2·54
Manganese	—
Cobalt	0·32
Copper	—
Selenium	0·050

C.

Iron	95·04
Nickel	3·20
Cobalt	0·12
Copper	0·20
Manganese	0·12
Selenium	0·04

D.

Iron	88·20
Nickel	8·20
Cobalt	0·12
Copper	—
Manganese	0·23
Selenium	0·06

E.

Iron	70·01
Nickel	20·02
Cobalt	—
Copper	—
Manganese	—
Selenium	0·08

F.

Iron	86·52
Nickel	10·52
Cobalt	0·12
Copper	—
Manganese	—
Selenium	0·05

ON THE

CONSTANCY IN THE HEAT PRODUCED BY THE REACTION OF ARGENTIC NITRATE ON SOLUTIONS OF METALLIC CHLORIDES.*

By THEODORE W. RICHARDS.

Having observed in some experiments made solely for practice that the heat produced by the precipitation of silver chloride from aqueous solutions of several metallic chlorides was directly proportional to the amount of silver nitrate used, the following investigation was made in order to determine whether this relation was really exact.

A standard solution of argentic nitrate was peparared by dissolving 100 grms. of $AgNO_3$ in one litre of water and diluting to 1250 c.c. 50 c.c. of this solution diluted to just 250 c.c. were used in each determination (except once when twice that amount was used), and the solutions of the various chlorides were made up so that 250 c.c. would contain a grm. or so more salt than was necessary to precipitate the quantity of silver nitrate used.

As the investigation was a question of comparison rather than of absolute measures, great care was taken to render the conditions as uniform as possible. For this purpose all the solutions and apparatus were left for twenty-four hours in a room of nearly constant temperature before being used.

The calorimeter was similar in every respect to that described by Berthelot, and the method of operation was exceedingly simple. In every case 250 c.c. of the solution of the metallic chloride were poured into the platinum calorimeter, and at the same time 250 c.c. of the silver solution (containing 4 grms. of $AgNO_3$ as stated above) were poured into a beaker, which had a capacity, when filled to the brim, of 255 c.c. The beaker was rested upon many folds of a non-conducting cloth, and surrounded by a cardboard cylinder with a movable cover.

When the temperatures of the liquids in both the calorimeter and the beaker (which were at first very nearly the same) had become constant after much stirring, they were noted, and the beaker was grasped by a heavily gloved hand and its contents poured rapidly into the calorimeter, the temperature of the resulting mixtures being noted.

Following is an example taken at random from the notebook.

Temperature of NH_4Cl sol. in calorimeter	17·220°
,, ,, $AgNO_3$ sol. in beaker	17·280°
Mean	17·250°
Final observed temperature	18·000°
Rise of temperature	0·750°

In every case the maximum temperature was attained in ten to fifteen seconds, so that no correction for cooling was necessary.

The water equivalent was always as follows:—

Solutions, 500 grms.; platinum calorimeter, 3·5 grms.; platinum stirrer, 1·5 grms.; thermometer, 5 grms. Total water equivalent = 505·5 grms.

Below is a table of all the results found.

The first column contains the number of the experiment, the second the chloride acted upon, the third the

* *Proceedings of the American Academy of Arts and Sciences.*

observed rise of temperature, and the fourth the amount of heat evolved in calors, and the last column the difference between the amount in each case and the average amount.

	°		
1. Sodic Chloride, NaCl .	0·760	16,220	+65
2. " " " ..	0·750		
3. Potassic Chloride, KCl	0·750	16,110	−55
4. " " " ..	0·750		
5. Ammonic Chloride, NH_4Cl	0·755	16,170	+5
6. Ammonic Chloride, NH_4Cl	0·750		
7. Barium Chloride, $BaCl_2$	0·750	16,110	−55
8. Cupric Chloride, $CuCl_2$	0·757	16,270	+115
9. Zinc Chloride, $ZnCl_2$..	0·760	16,320	+165
10. Manganese Chloride, $MnCl_2$	0·745	16,010	−155
11. Nickel Chloride, $NiCl_2$	0·755	16,110	−55
12. " " "	0·745		
13. Ferrous Chloride, $FeCl_2$	0·745	16,010	−155
14. Aluminic Chloride, Al_2Cl_6.	0·745	16,010	−155
15. Ferric Chloride, Fe_2Cl_6	1·520*	16·320	+165
16. " " "	0·760		
17. Chromic Chloride, Cr_2Cl_6.	0·760	16,320	+155
18. Hydrochloric Acid, HCl	0·760	16,170	+5
19. " " "	0·740		
20. " " "	0·755		
Average	0·7526	16,165	

It will be seen that all of these results are identical within the limit of error of the process. We may, therefore, draw the conclusion that the amount of heat evolved by the reaction thus represented—

$$({}^{1}_{n}R_m Cl_n + AgNO_3 + Aq) = AgCl + ({}^{1}_{n}R_m (NO_3)_n = Aq),$$

is constant, no matter what R, m, or n may be.

Hence, also, *the difference between the heats of formation of equivalent amounts of nitrate and chlorides in aqueous solution is the same for any metal or basic radical.*

METHODS FOR DETERMINING PHOSPHORIC ACID AND MOISTURE.†

(1) *Preparation of Sample.*—The sample should be well intermixed and properly prepared, so that separate portions shall accurately represent the substance under examination, without loss or gain of moisture.

(2) *Determination of Moisture.*—(*a*) In potash salts, nitrate of soda, and sulphate of ammonia heat 1 to 5 grms. at 130° C. till the weight is constant, and reckon water from the loss. (*b*) In all other fertilisers heat 2 grms., or, if the sample is too coarse to secure uniform lots of 2 grms. each, 5 grms., for five hours at 100° in a steam-bath.

(3) *Water-soluble Phosphoric Acid.*—Bring 2 grms. on a filter, add a little water, let it run out before adding more water, and repeat this treatment cautiously until no phosphate is likely to precipitate in the filter. If the washings show turbidity after passing the filter, clear up with acid. When the substance is nearly washed in this manner, it is transferred to a mortar and rubbed with a rubber-tipped pestle to a homogeneous paste (but not further pulverised), then returned to the filter and washed with water until the filtrate measures not less than 250 c.c. Mix the washings. Take an aliquot (usually corresponding to ⅛ or ½ grm. of the substance) and determine phosphoric acid, as under "Total Phosphoric Acid."

(4) *Citrate-insoluble Phosphoric Acid.*—Wash the residue of the treatment with water into a 200 c.c. flask with 100 c.c. of strictly neutral ammonium citrate solution of 1·09 density, prepared as hereafter directed. Cork the flask securely and place it in a water-bath, the water of which stands at 65° C. (The water-bath should be of such a size that the introduction of the cold flask or flasks shall not cause a reduction of the temperature of the bath of more than 2° C.) Raising the temperature as rapidly as practicable to 65° C., which is subsequently maintained, digest with frequent shakings for thirty minutes from the instant of insertion, filter the warm solution quickly (best with filter-pump), and wash with water of ordinary temperature. Transfer the filter and its contents to a capsule, ignite until the organic matter is destroyed, treat with 10 to 15 c.c. of concentrated hydrochloric or nitric acid, digest over a low flame until the phosphate is dissolved, dilute to 200 c.c., mix, pass through a dry filter, take an aliquot, and determine phosphoric acid as under "Total."

In case a determination of citrate-insoluble phosphoric acid is required in non-acidulated goods, it is to be made by treating 2 grms. of the phosphatic material, without previous washing with water, precisely in the way above described, except that in case the substance contains much animal matter (bone, fish, &c.) the residue insoluble in ammonium citrate is to be treated by one of the processes described below.

(5) *Total Phosphoric Acid.*—Weigh 2 grms., and treat by one of the following methods; (1) Evaporation with 5 c.c. magnesium nitrate, ignition, and solution in acid. (2) Solution in 30 c.c. concentrated nitric acid with a small quantity of hydrochloric acid. (3) Add 30 c.c. concentrated hydrochloric acid, heat, and add cautiously and in small quantities at a time about 0·5 grm. of finely pulverised potassium chlorate.

Boil gently until all phosphates are dissolved and all organic matter destroyed; dilute to 200 c.c., mix and pass through a dry filter; take 50 c.c. of filtrate, neutralise with ammonia (in case hydrochloric acid has been used as a solvent add about 15 grms. dry ammonium nitrate or its equivalent). To the hot solutions for every decigramme of P_2O_5 that is present, add 50 c.c. of molybdic solution. Digest at about 65° C. for one hour, filter, and wash with ammonium nitrate solution. (Test the filtrate by renewed digestion and addition of more molybdic solution.) Dissolve the precipitate on the filter with ammonia and hot water, and wash into a beaker to a bulk of not more than 100 c c. Nearly neutralise with hydrochloric acid, cool, and add magnesia mixture from a burette; add slowly (one drop per second), stirring vigorously. After fifteen minutes add 30 c.c. of ammonia solution of density 0·96. Let stand several hours (two hours are usually enough). Filter, wash with dilute ammonia, ignite intensely for ten minutes, and weigh.

(6) *Citrate-soluble Phosphoric Acid.*—The sum of the water-soluble and citric-insoluble subtracted from the total gives the citrate-soluble.

Preparation of Reagents.

(1) *To prepare Ammonium Citrate Solution.*—Mix 370 grms. of commercial citric acid with 1500 c.c. of water; nearly neutralise with crushed commercial carbonate of ammonia, heat to expel the carbonic acid, cool, add ammonia until exactly neutral (testing by saturated alcoholic solution of coralline), and bring to volume of 2 litres. Test the specific gravity, which should be 1·09 at 20° C. before using.

(2) *To prepare Molybdic Solution.*—Dissolve 100 grms. of molybdic acid in 400 grms. or 407 c.c. of ammonia of specific gravity 0·96, and pour the solution thus obtained into 1500 grms. or 1250 c.c. of nitric acid of specific gravity 1·20. Keep the mixture in a warm place for several days, or until a portion heated to 40° C. deposits no yellow

* In this experiment 8 grms. of $AgNO_3$ were used.

† Official Methods of Analysis of the Association of Official Agricultural Chemists for 1887-88. U.S. Department of Agriculture, Division of Chemistry.

precipitate of ammonium phospho-molybdate. Decant the solution from any sediment, and preserve in glass-stoppered vessels.

(3) *To prepare Ammonium Nitrate Solution.*—Dissolve 200 grms. of commercial ammonium nitrate in water, and bring to a volume of 2 litres.

(4) *To prepare Magnesia Mixture.*—Dissolve 22 grms. of recently ignited calcined magnesia in dilute hydrochloric acid, avoiding excess of the latter. Add a little calcined magnesia in excess, and boil a few minutes to precipitate iron, alumina, and phosphoric acid; filter, add 280 grms. of ammonium chloride, 700 c.c. of ammonia of specific gravity 0·96, and water enough to make the volume of 2 litres. Instead of the solution of 22 grms. of calcined magnesia, 110 grms. of crystallised magnesium chloride ($MgCl_2,6H_2O$) may be used.

(5) *Dilute Ammonia for Washing.*—One volume ammonia, of specific gravity 0·96, mixed with 3 volumes of water, or usually 1 volume of concentrated ammonia with 6 volumes of water.

(6) *Nitrate of Magnesia.*—Dissolve 320 grms. of calcined magnesia in nitric acid, avoiding an excess of the latter; then add a little calcined magnesia in excess, boil; filter from excess of magnesia, ferric oxide, &c., and bring to volume of 2 litres.

LEAD SLAGS.

By MALVERN W. ILES.

(Continued from p. 7).

Chemical Properties.

General Composition.— Lead slags are chiefly silicates of iron and lime; aside from these bases, manganese not infrequently plays an important part, as seen by analyses Nos. 9, 36, 37, 49, and 50. Zinc, alumina, baryta, and magnesia also sometimes enter slags as important constitutents, but these bases when present to any considerable extent will occasion trouble and are to be avoided if possible.

In argentiferous lead smelting the slag will always contain some lead and silver; in many cases these elements only exist in minute traces. From the fuel the slags derive some potassium and sodium and also phosphorus, but the amount is, however, quite small. Sulphur will always be found; the amount usually varies from 0·5 to 2 per cent. When copper ores enter the smelting mixture, some of this metal will also enter the slag, particularly in re-working the cupriferous matte; Dr. Wedding reported 0·27 per cent Cu_2O in the Saint Andreasberg slag in one instance, and in another case 0·50 per cent. In an analysis of the Clausthal slag, made in 1870, Hampe reported $NiO + CoO$, Cu_2S, and SbS_3; the phosphorus was reported as PO_5. Certain lead slags of Spain were once used as a source of vanadium. At Leadville, at one time, no less than three different mines were yielding vanadium in noticeable quantities. I have known a large ore mixture or "bed" to be smelted which contained no inconsiderable amount of these vanadium ores, and have detected vanadium in ores from the following different Leadville mines: Morning Star, Evening Star, Waterloo, Etna, and especially in ore from the Park mine. The Little Ellen mine, at Red Cliff, Colorado, was also found to contain a green vanadium mineral (supposed to be descloizite). Owing to the above mentioned facts, I think that vanadium is no uncommon constituent of the Leadville slags.

Aside from the above-mentioned elements, which are chemically combined, I have noted certain abnormal slags containing as a mechanical mixture portions of quartz varying in size from a mere speck to large white, usually rounded, pebbles from 2 to 3 inches in diameter. These pebbles were worked out through the tapping hole with difficulty, and when broken showed a dull, white colour resembling that of unglazed porcelain. Then again I have noticed sesquioxide of iron, sometimes in pieces an inch large; also pieces of quicklime; this, however, has only been observed when the furnace was being "blown out." In one instance quite a large piece (a quarter of an inch in length) of sulphide of zinc was found which was highly crystallised; this occurred at the very bottom of a cone of slag after breaking off the matte cake.

Before passing from this subject, it may be well to mention that by closely observing the very top of a pot of slag there will very often be found in blistered cavities exceedingly delicate needles; sometimes these crystals will appear almost white, then again of a yellowish tint (this is supposed to be due to oxide of zinc), and again others of a distinctly bluish tint. These bluish crystals have been found to contain both sulphur and lead, and are perhaps a subsulphide. These delicate crystals I have most frequently seen when the production of matte was large, although one of my metallurgical friends informs me that he also has noticed these crystals when scarcely any matte was formed. Shot-like globules of metallic lead have been observed in certain highly siliceous slags. Whenever the production of iron matte is unusually large it is not an uncommon thing to find rounded globules of it in the slag; this is particularly the case on the very outer rim of the pot.

Modes of Decomposition.—The ordinary method of fusing slags with carbonate and nitrate of soda in a platinum crucible will sometimes give good results; but since the slag always contains more or less lead it will be readily seen that the analyst runs the risk of either injuring or completely spoiling the platinum crucible by the reduction of metallic lead. A very good method of proceeding when the samples are not taken according to the method to be subsequently described, is to powder the slag well in an agate mortar, then digest with strong hydrochloric acid, evaporate once to complete dryness upon the water-bath; then add more hydrochloric acid, filter, and fuse (or, better, agglomerate, or semi-fuse) the residue with sodium carbonate in a platinum crucible, and proceed as usual according to the well known method for the determination of insoluble silicates.

The above mode of precedure is found somewhat long for the practical uses in connection with industrial works, where time is a great desideratum. To facilitate the fusion and also to prevent the liability of destroying costly platinum crucibles, I have for a long time used a method of fusing the slag in a silver crucible with caustic potash and then proceeding as usual in the analysis. The method last described has the advantage that the heat required for the fusion is quite small, in fact an ordinary alcohol lamp is found sufficient; and as many laboratories connected with the lead smelting works have neither gas nor the improved gasoline burners, the method is therefore very serviceable. The disadvantage is that the silver crucible is always slightly attacked by the caustic alkali, and when a complete analysis is to be performed the silver gives trouble in some of the determinations. This difficulty is, however, entirely overcome if a platinum crucible is heavily plated with gold, as has been suggested by W. Bettel in the Chemical News.

A method which I will now describe has been used for several years in connection with these works, and leaves little to be desired. If in taking the laboratory sample we use an ordinary steel bar, throw aside the crust from a newly-drawn pot of slag, dip the reversed end of the bar about 2 inches into the molten slag, then quickly plunge into a bucket of water, and use this sample for analytical determinations, it will be found that all slags made in lead smelting will be entirely decomposed by strong hydrochloric acid, giving rise to perfectly pure gelatinous silica.

By using a small amount of acid, and with a little practice, one can determine the silica, iron, and lime contained a slag in less than two hours.

Quantitative Analysis.—After taking the slag sample, as previously indicated, weigh out from half a grm. to one

grm., transfer to a covered casserole, add from the wash bottle a few drops of water, stir well, and add concentrated hydrochloric acid; again stir, and digest over a free flame for a few minutes. The addition of water and the stirring prevent the slag from clotting or caking upon the bottom of the vessel. Now add a few drops of nitric acid, both to insure the oxidation of the iron and also to decompose the few particles of lead sulphide which are apt to form during the first addition of hydrochloric acid, and rise upon the sides of the vessel. Sometimes these black specks are due to carbon, which will, of course, be burned off in the ignition of the silica. Evaporate to dryness upon the water-bath; this is not a long operation if the analyst uses a minimum quantity of acid (sav, 6 to 8 c.c.). After the evaporation is completed add a few drops of water, just sufficient to moisten the mass, and evaporate a second time. Now add a slight excess of concentrated hydrochloric acid; warm, dilute, and filter, washing the silica with boiling water, and drop a small amount of hydrochloric acid around the edges of the paper; wash again with water. The moist residue, with the paper, is transferred directly to either a porcelain or a platinum crucible, placed in an ordinary scorification cup, and dried before the assay muffle until the paper begins to carbonise. It is then placed in the muffle for about five minutes, removed and allowed to cool, and the silica is then weighed. The silica will be found perfectly white, not even tinted with iron, and the determination is as accurate as if a fusion had been performed.

For the determination of the iron it is advisable to take a second portion of half a grm., boil with hydrochloric acid to complete decomposition in a casserole, then dilute with water and add a small piece of unamalgamated zinc directly into the covered vessel. After a few minutes the cover is removed, washed, and the contents of the casserole are cautiously transferred by decantation to a large beaker, and diluted with water up to 500 c.c.; now add rather a large amount of concentrated sulphuric acid (say 25 c.c.) and titrate the iron with a standard solution of potassium permanganate.

It will be noted that it is entirely unnecessary to remove the silica in order to determine the iron, and furthermore time is saved by reducing the iron by unamalgamated zinc directly in the vessel in which the decomposition of the slag is effected. For commercial work a solution of permanganate is made by dissolving 5·686 grms. of the salt in one litre of water.

For the estimation of lime two methods are used, according to the degree of accuracy to be attained. If, for quick work, we wish to ascertain the percentage of lime we use the filtrate from the silica as follows:—Heat this filtrate, add ammonia to a slight alkaline reaction, then add a saturated solution of oxalic acid to dissolve the iron; boil for a few minutes, allow to stand twenty-five minutes, filter hot, wash well, and transfer to a casserole; add some hot water and sufficient hydrochloric acid to dissolve the calcium oxalate, filter, and dilute with cold water. Now add rather a large amount of sulphuric acid, heat to boiling, and titrate with the same solution of permanganate as was used in the iron determination. If a greater degree of accuracy is desired the iron and alumina are removed as basic acetates, then the manganese is separated by bromine water, the zinc removed by sulphuretted hydrogen, and the filtrate treated according to the usual methods for estimating the lime.

Some manganese will invariably pass into the filtrate when the iron is precipitated by ammonia, and will come down with the lime, thus introducing an error to the extent of its presence. When, however, the amount of manganese is small in comparison to the amount of iron, we can often use the first-mentioned method with a great saving of time.

For the determination of the manganese, from 1 to 2 grms. of the finely divided slag is used, according to the amount present: this is treated in a casserole with concentrated hydrochloric acid, with the addition of a small amount of nitric acid in order to convert all the iron into the ferric form. Now boil, and add sulphuric acid, gradually replacing all of the nitric acid, and also hydrochloric acid: the success of the operation depends upon the entire removal of the hydrochloric acid. Dilute to about 150 c.c. and boil; add an emulsion of zinc oxide in large excess, by which the iron is precipitated as ferric hydrate; filter off the silica and oxides of zinc and iron, and dilute to 500 c.c. Some writers recommend, before the addition of zinc oxide, neutralising with sodium carbonate, and then clearing the solution with a few drops of nitric acid; this in practice is found to be unnecessary. Draw off from the diluted liquid, after thorough mixing, an aliquot part (say 100 c.c.), transfer to a casserole, heat to boiling, and titrate with frequent stirring with the same permanganate as was used for the iron and lime until the first rose tint is observed. Calculate the percentage of iron corresponding to the permanganate used, and multiply this percentage by 0·2946 (=per cent Mn). The manganese scheme as above stated is highly recommended, both for its rapidity and accuracy; in fact there is no known method which I think will compare with it for technical and scientific work.

The sulphur is determined by the "Fahlberg-Iles" method as follows:—Fuse 1 to 2 grms. of finely divided slag in a silver crucible (or gold-lined platinum crucible) with 25 grms. potassic hydrate for twenty minutes; cool, dissolve in water, filter off the hydrated oxides of iron, &c.; now add 30 c.c. bromine water, and then concentrated hydrochloric acid to an acid reaction; boil off excess of bromine, filter if necessary, add barium chloride, and proceed as usual for the treatment of barium sulphate.

If other constituents are to be determined the methods are followed as given by Fresenius, Rose, Sutton, Cairns, or Hart.

(To be continued).

VALUATION OF INDIGOES.

An Investigation into the Various Methods Employed for the Estimation of Indigotin, together with certain New and Modified Processes.*

By CHRISTOPHER RAWSON, F.C.S.

(Continued from p. 8).

Action of Potassium Permanganate upon Indigo-Gluten, Indigo-Brown, and Indigo-Red.—I have made a few experiments in order to discover, if possible, how the various constituents of indigo are affected by potassium permanganate. Twenty grms. of a medium quality of indigo were successively treated with hydrochloric acid, sodium hydrate, and alcohol. These extracts were separately evaporated to dryness, and a weighed portion of each treated with concentrated sulphuric acid, and afterwards diluted with water and filtered. The filtered solution in each case was mixed with 50 c.c. of a standard solution of pure indigo-sulphate, and titrated with potassium permanganate. The "alcoholic extract," consisting principally of indigo-red, dissolved in sulphuric acid with a dark crimson colour, but, on the addition of water, a brown precipitate formed, showing that some indigo-brown was also present in the extract.† An exact quantitative result cannot be given, but, judging from the amount of permanganate decolourised, it appears that indigo-red acts upon potassium permanganate in a similar manner to indigotin. The "sodium hydrate extract," consisting of indigo-brown, dissolved in sulphuric acid with a deep dark brown colour, but, on the addition of water, it was almost entirely precipitated. The filtered solution had very little action upon potassium permanganate. The "hydrochloric acid

* *Journal of the Society of Dyers and Colourists*, No. 4, Vol. I.
† This experiment would have been repeated, but time did not permit.

extract" contains indigo-gluten resinous substances, mineral matter, &c. The solution decolourised a considerable amount of permanganate, which was found to vary in quantity, according to the quality of the indigo from which the extract had been prepared. Much of this decolourising action was found to be due to the presence of iron in the ferrous state. Indigo-red can scarcely be considered an impurity of indigo, and as indigo-brown does not sensibly affect the results it is evident that the inaccuracy of the permanganate method is due to the presence of substances soluble in hydrochloric acid.

In order to eliminate this error I have made use of the property of sodium sulphindigotate, being insoluble (or nearly so) in a strong solution of common salt. As the precipitate does not immediately separate from solution, the modified process takes a somewhat longer time to perform, but the amount of extra labour is very little, and what is most important, very good results are obtained. The 50 c.c. of the filtered solution of indigo, instead of being directly titrated with permanganate, are mixed in a small flask with 50 c.c. of water, and 32 grms. of common salt. The liquid, which is thus almost saturated with salt, is allowed to stand for two hours,* when it is filtered and the precipitate washed with about 50 c.c. of a solution of salt (sp. gr. 1·2). The precipitated sulphindigotate of soda is dissolved in hot water, the solution is cooled, mixed with 1 c.c. sulphuric acid, and diluted to 300 c.c. The liquid is then titrated with potassium permanganate as before. It is necessary to make a slight correction in order to allow for the small quantity of sodium sulphindigotate which dissolves in a saturated solution of common salt. This correction I have found in my own experiments to be 0·0008. On reference to Table No. II. it will be seen that results obtained by this modified process agree on the whole very closely with the combined percentages of indigotin and indigo-red.

Calculation of results :—

Example I.—By direct titration—

(One c.c. potassium permanganate = 0·0015 indigotin). 1 grm. of "Kurpah" indigo was dissolved in sulphuric acid, diluted to a litre, and filtered; 50 c.c. (= 0·05 indigo) diluted with 250 c.c. of water required 14·5 c.c. of permanganate;

$$\therefore \frac{0{\cdot}0015 \times 14{\cdot}5 \times 100}{0{\cdot}05} = 43{\cdot}50 \text{ per cent indigotin.}$$

Example II.—After precipitation by sodium chloride—

Fifty c.c. (= 0·05 indigo) of the above solution were mixed with 50 c.c. of water and 32 grms. of common salt. The precipitate was collected on a filter and dissolved in 300 c.c. of water containing 1 c.c. of sulphuric acid. This solution required 12·7 c.c. of permanganate;

$$\therefore \frac{(0{\cdot}0015 \times 12{\cdot}7 + 0{\cdot}0008) \times 100}{0{\cdot}05} = 39{\cdot}70 \text{ p. c. indigotin.}$$

Potassium Ferricyanide Process.—This method, which was recommended by Ullgren, may be found fully described in the *Journal of the Chemical Society*, 1865, p. 223. It is based upon the fact that potassium ferricyanide (red prussiate of potash), in the presence of free alkali, changes indigo blue into isatin. Ullgren says that the quantity of sulphuric acid employed for dissolving the indigo must not be more than ten times the weight of the indigo taken, and that the mixture should not be exposed to a temperature exceeding 50°. When 1 grm. of indigo has been dissolved and diluted to 1 litre, 10 c.c. are taken and mixed with 20 c.c. of a cold saturated solution of sodium carbonate, and 1 litre of distilled water in a porcelain basin; a weak solution of potassium ferricyanide (2·5115 to litre) is gradually added during constant stirring with a glass rod. The impurities present in commercial indigoes do not so much interfere with this reaction as in the methods previously mentioned, still the results obtained are too high, and, furthermore, as both the solution of indigo and that of the ferricyanide must necessarily be very dilute, the end of the reaction is not sharp, and consequently analyses made with the same sample of indigo do not agree so well as those obtained by the permanganate method.

(To be continued.)

* If the liquid be strongly agitated by drawing a current of air through the solution, the precipitate completely separates in less than half an hour.

NOTICES OF BOOKS.

A Course of Quantitative Analysis for Students. By W. N. Hartley, F.R.S. London and New York: Macmillan and Co.

The author takes for his motto the saying of Fresenius, that "One may be a good analyst without having tried *every* method or determined *every* body." In the spirit of this very true dictum he gives us not a complete series of methods for the determination of every known body, but a judicious selection of procedures calculated to instruct the student in most matters with which the analyst should be familiar. In his Preface he remarks that "to be a good analyst does not necessitate a profound knowledge of chemistry, nor does the possession of extensive knowledge and a brilliant intellect enable one to dispense with practice in the execution of analytical operations." He might have added that here, as in many other spheres of activity, knowledge—however profound—is insufficient without a certain tact impossible to be described.

The work opens with a table of metrical weights and measures and their English equivalents, concerning which we have merely to remark that a comparison between the cubic inch or the fluid ounce and the cubic centimetre is less useful than would be one between the latter and the grain-measure.

The Introduction, which follows next, consists of very judicious directions concerning manipulation. Though the space devoted to this subject is necessarily limited, we are much pleased with the nicety evinced. The student is forewarned against possible sources of error which we have seen overlooked in bulkier works.

After this section we come to a series of introductory examples, intended mainly to convey the meaning of atomic weights and equivalent weights.

A table is given for some of the more important elements of the atomic weights as commonly used, as revised, as calculated by F. W. Clarke, on the basis O = 15·963, and those by Van der Plaats, O = 16. The author considers that for commercial purposes it is almost as necessary to use the ordinary atomic weights as it is to buy and sell by the legalised weights and measures. To employ the old atomic weight for platinum, Pt = 197, must, however, involve a grave error.

We next find estimations of mineral constituents, *e. g.*, of moisture, sodium, chlorine, sulphuric acid, copper, carbonic acid, lime, magnesia, &c. The methods prescribed are satisfactory, and they are most clearly and carefully described.

In the section on volumetric analysis we note that the author uses nitric acid in alkalimetry. The determinations here given for water are those of chlorine and of hardness.

Under "Technical Analysis" we find instructions for the quantitative examination of coal, pyrites, burnt ore, and superphosphate. As regards this last substance there is no mention of the determination of "reverted" phosphoric acid.

The last main section of the work treats on the analysis of alloys and complex minerals.

As an Appendix follow hydrometer tables. Organic analysis does not come within the author's plan, though he has given volumetric processes for the determination of sugar and of urine.

The only defect of moment which we perceive in this book is the absence both of a table of contents and of an index. The work will be of great use not merely to the student who is seeking to master the principles and practice of analysis, but occasionally even to the matured and experienced chemist.

A Text-Book of Paper-making. By C. F. Cross and E. J. Bevan. London and New York: E. and F. N. Spon.

Messrs. C. F. Cross and E. J. Bevan are generally and favourably known to chemists from their important researches on cellulose, and we therefore welcome their work on the paper trade. There is, perhaps, no other industry of equal importance which has so scanty a literature. This deficiency is by no means peculiar to England, if we may judge from the bibliography appended to the volume before us, in which are enumerated only sixteen complete works and three journals. Whether this paucity is due to the scarcity of scientific research, or to an indisposition on the part of practical men to discuss trade questions, it might be unsafe to pronounce.

The authors begin their task with an examination of the chemistry and the natural history of the cellulose group. They note the general inertness of cellulose and the paucity of its reactions. The nitro-compounds are described from the hexa-nitrate—formerly known as trinitro-cellulose—down to the dinitrate, a body hitherto but little studied. We have also an account of the oxygen compound, the α-oxycellulose of Witz, characterised by its well-marked affinity for the basic colouring-matters, which dye it full shades, and by its remarkable attraction for the vanadium compounds.

Under the decomposition products of cellulose they mention amyloid, commonly known—in some forms at least—as parchment-paper, and its near ally hydro-cellulose, as also β-oxycellulose, first described by the authors. We cannot help suggesting that a more complete study of cellulose and its products from a tinctorial point of view might prove of importance to the dyer and printer. The action of alkalies upon cellulose is here described, but there is no reference to mercerisation.

It is mentioned that the soluble ferment of the foxglove converts cellulose into glucose and dextrine, and that the fluid from the vermiform appendage of the cœcum of the rabbit digests cellulose, with formation of a saccharine product and the liberation of marsh-gas. On the other hand, the so-called "vinegar plant" is capable of transforming levulose into cellulose. The synthesis of cellulose, which is effected spontaneously in beet-juice, has not been generally investigated.

In certain plants there occurs a formation of compound celluloses, a class of bodies of which jute may serve as the type. The authors consider that the chemistry of jute throws a light on the process of lignification.

The reactions of jute, or we may say of ligno-cellulose in general, differ distinctly from those of unmodified cellulose. On its reaction with iodine the authors found their method for the determination of (mechanical) wood-pulp in paper. But if anyone wishes to learn how far-reaching is the chemistry of cellulose, and what closed doors—theoretical as well as technical—it may yet unfasten, we must recommend him a careful study of the remaining portion of this chapter.

The authors then enter upon the study of the physical structure of fibres, as a necessary preliminary to their microscopic and micro-chemical examination and diagnosis. Here we find a classification of the plant fibres which come under the hands of the paper-maker and the dyer. There are first the cottons, which are seed-hairs, the purest form of cellulose occurring in Nature; then the bast-fibres, partially lignified cellulose, such as flax, hemp, China grass, ramie, jute, paper mulberry, and linden-bast. Lastly come the fibro-vascular bundles met with in New Zealand flax and esparto.

A following chapter gives a formal scheme for the analysis, qualitative and quantitative, of plant substances. Next follows an account of the chemical and physical features of the more important raw materials, with illustrations showing their appearance under the microscope. This chapter will be of especial value to the student who wishes to familiarise himself with the structure of the various fibres. The chemical reactions and the percentage compositions of the raw fibres are duly given. Jute is mentioned as containing 24 per cent of lignine to 63 of true cellulose, whilst cotton contains no lignine and 91 of cellulose.

The authors then pass to the general processes by which the paper-maker isolates celluloses in available forms from the raw materials above described. These processes resolve themselves into two main groups, the alkaline and the acid treatment, the agents employed in the former being soda, caustic or carbonated, and lime, whilst in the latter processes sulphurous acid plays a principal part. This process is very carefully described, though we find no reference to the claims of the younger Mitscherlich, and to his contention that the prior invention of Tilghman should not be held to anticipate his patent.

The discussion of the special treatment of various fibres introduces the distinction between the two kinds of wood-pulp, the chemical and the mechanical, so called from the nature of the processes by which the wood is reduced to fibres. The authors observe that mechanical wood-pulp has little felting power, and that paper containing it readily becomes discoloured by the action of air and light.

In the chapter on bleaching we find a favourable notice of the electrolytic process of M. Hermite, which the authors consider economically advantageous. They state that "if a solution be taken of equal oxidising efficacy with one of calcium hypochlorite it is found that the former possesses greater bleaching efficiency in the proportion of 5 to 3." The bleaching is also more rapid, and the loss of weight, for equal degrees of whiteness, is smaller. As the process is now in industrial action, this estimate will soon be either practically verified or refuted.

The remaining chapters of the work, into which we have not space to enter, are devoted to the consideration of beating, loading, sizing, and colouring, the recovery of caustic soda, testing papers chemically and mechanically, general chemical analysis for paper-makers, and the Willesden paper process.

Messrs. Cross and Bevan may be congratulated on having produced *the* book on the paper-industry.

Colour: an Elementary Manual for Students. By A. H. Church, M.A., F.C.S., F.I.C., Professor of Chemistry in the Royal Academy of Arts, London. New and enlarged Edition. London, Paris, New York, and Melbourne: Cassell and Co.

The former edition of this Manual appeared as far back as 1871, and has been long out of print. Hence the present issue, which is much enlarged, may fairly be regarded as a new work. Prof. Church addresses himself mainly and as by right to artists; but in our opinion his treatise will prove of very great value to chemists and biologists, who constantly require to perceive colours accurately and to describe them faithfully. It may also be recommended to dyers, tissue printers, and fancy manufacturers. Many a time has our soul been troubled by seeing colours in textile goods, in themselves pure and beautiful, so arranged that instead of enhancing they deteriorated each other.

The first chapters of the work are devoted to a general explanation of the general principles of optics, necessary for an understanding of what has to follow. At the very outset he reminds his readers that "colour is, in fact, an internal sensation, and has no external and objective existence." This simple truth is very often overlooked,

even by persons whose pursuits require the constant scrutiny of colour.

We are by no means sorry to find a criticism of the relationships often assumed between sound and light. Prof. Church points out that whilst sound-waves move in the direction of their path, light-waves move transversely; that there is no definite ratio between the typical colour intervals and the musical intervals of the octave; that the eye appreciates differences in wave-lengths in the middle region of the spectrum better than at either end, whilst the ear does not evince a similar peculiarity with relation to musical sounds. Again, we *see* but one octave of colours, though we hear eleven octaves of sounds. Whether there is any meaning in the fact that we have an octave alike in sound, in colour, and in the natural arrangement of the chemical elements,—Mr. Newlands originally proposed for the "periodic law" the name Law of Octaves,—or whether we have here a casual coincidence, it would be premature to decide.

The "symbolism of colour," the author holds, "scarcely admits of serious consideration." In many respects this is doubtless true. Still there is one consideration not unworthy the attention both of artists and *savants*. It is this: in the organic world beings normally display purer and brighter colours as they approach their summit of development, whilst decline, disease, and death are heralded by impure colouration.

Chapter V. contains the definition of some terms often used in a very loose manner. The *hue* of any colour is its difference, as red or orange, green or blue, &c. *Purity* is the absence, more or less complete, of any admixture of white, and brightness is the total amount of light reflected to the eye. Under this head we find mention of Capt. Abney's curious observation that at great elevations the region of maximum luminosity in the spectrum is shifted from its ordinary position about D towards the more refrangible end.

By *tints* Prof. Church understands the normal hue mixed with progressively increasing quantities of white. By *shades* he means the normal hue mixed with progressive increments of black. It is to be regretted that these terms are not used in the same sense by all who have to work with colours. What are here called *hues* are named by dyers and colour manufacturers *tones*, who apply the term *shades* to the different grades of concentration of one and the same hue in the utter absence of any admixture of black.

The author regrets the confusion existing between violet and purple, which are often taken as synonymous. He evidently hopes that some day an "International Colour Standard Conference" of artists and scientists may fix upon a nomenclature, to be preserved by means of hues reproduced in enamel.

To give an analysis of the latter portion of the work, where the mutual relations of colours are considered, would be impracticable within our limits. Some of the practical applications of general principles may be briefly touched upon.

The author remarks on the difficulty, and sometimes the impossibility, of properly associating marbles and similar natural materials with tiles. In marble there is some approach to translucency with which the dull, dry, opaque surface of pottery contrasts unpleasantly. Again, in a carved capital of variegated material, "Nature's designs in colour are disfigured by man's work in light and shade, and the sculpture itself is ruined by the casual way in which the projecting portions are here and there darkened by a rich mottling, whilst the recesses are brought into prominence by reason of the paleness of that part of the marble in which they are wrought."

Whoever reads this book carefully will, we think, agree with us that if the principles here clearly expounded were followed out in our art manufactures, we should indeed welcome a *renaissance*.

Modern American Methods of Copper Smelting. By E. D. Peters, Jun., M.D., M.E. New York: Scientific Publishing Company.

The author of this useful work arranges the copper districts of North America in four groups, viz., the beds of the Atlantic Coast, the deposits of Lake Superior, the system of the Rocky Mountains and the Sierra Nevada, and, finally, the deposits of Arizona and New Mexico. The Lake Superior deposits are remarkable for the abundant occurrence of native copper. Their value depends not so much on a high percentage of metal as on its occurring in a state which renders unnecessary the costly series of calcinations and fusions necessary in sulphuretted copper-ores, and on the absence of arsenic and other impurities. In New Mexico and Texas the metal occurs in the shape of fossilised shells, fishes, leaves, and twigs, all transmuted into impure copper glance. Malachite does not occur in the United States of sufficient purity to be fit for ornamental purposes.

The chapter on copper assaying opens with an account of the sampling process. The Cornish method is laid aside in favour of certain automatic machines, of which that of Brunton, of Denver, which is here figured and described, receives the preference.

Four methods of copper assay are here described,—the Parkes titration process, precipitation with zinc or iron, the colorimetric process, and the electrolytic assay. The Parkes method he considers sufficiently accurate in the absence of zinc, antimony, and arsenic. The colorimetric method he reserves, as do English metallurgical chemists, for slags and tailings. The battery assay he finds suited to every class of ore and every percentage of copper, and as combining ease of execution and extreme accuracy. The Cornish assay he justly condemns, on account of its difficulty and inaccuracy. At the same time he considers that there is little immediate hope of its being abolished, on account of its being interwoven with the commercial customs of the Swansea smelters. He describes, however, at some length, a fire assay practised at Lake Superior, and apparently well adapted to the class of ores there to be dealt with.

He adds the interesting practical note that, in an establishment handling 35 tons per day, the cost of sampling per ton was 37 cents, and that of assaying 18¼ cents.

Coming to actual work we notice that the author does not touch upon the wet methods for the extraction of copper. To have done so would have increased the size and cost of the book to an undesirable extent. A praiseworthy feature is that he goes into the question of cost, both of construction and of subsequent working, "not calculating expenses as they appear on paper, and when everything is running smoothly, but giving the actual results of building on a large scale and of smelting many thousand tons of ores under varying circumstances and in all of the ordinary kinds of furnaces."

In successive chapters he discusses the roasting of copper ores in lump form, the term roasting being in America understood differently from in England, and signifying the exposure of ores containing sulphur, arsenic, and other non-metals to a comparatively moderate temperature for the purpose of effecting certain required chemical changes. This definition, he tells us, "is restricted to the dry metallurgy of copper. He then proceeds to stall-roasting, and to the roasting of ores in lump form in kilns. This latter operation is chiefly carried on with a view as much to the manufacture of sulphuric acid as to the calcination of ore. He states that if an ore contains 8 per cent of copper it cannot be profitably burnt for sulphuric acid. The Canadian cupreous pyrites used in the vitriol works of Boston and New York contains only 45 per cent of sulphur, on account of a greater percentage of gangue than is found in Spanish ores.

It appears that in Massachusetts a company erected plant for obtaining sulphuric acid and copper from iron monosulphide, which cannot contain more than 36 per cent of sulphur, and which behaves badly in the kilns.

The author considers that an ore containing as little as 25 per cent of sulphur may be burnt, if it has no otherwise objectionable properties. We never heard of an ore or mixture so low as this being used in any works in England.

After discussing the calcination of ore and matte in a finely divided condition, Dr. Peters passes on to the "Chemistry of the Calcining Process." Here the successive changes occurring at different stages of the process are clearly described.

The smelting of copper and the comparative advantages of blast furnaces and reverberatories are next discussed. For smelting ores the cupola is advantageous with highly ferruginous ores, where the cost of anthracite or coke is not much greater than that of bituminous coal, &c., for oxidised ores, for low-grade native copper, and where clean slags are a necessity. On the other hand, the author prefers the reverberatory for refractory siliceous, aluminous, calcareous, or magnesian ores, where the composition of the ore changes suddenly, where bituminous coal is very much cheaper than anthracite or coke, and for smelting and immediately refining rich native copper.

The chapter on the treatment of auriferous and argentiferous copper ores is very brief. The Ziervogel process is set aside as requiring very pure materials and exceptional skill, and as not providing for the extraction of gold. The electrolytic methods are still largely in the experimental stage. But the Hunt and Douglas method seems to suit the demands of the case better than any previous device.

The author has had practical experience in the Bessemerising of copper mattes. He finds that the elimination of antimony and arsenic was highly satisfactory, and believes that this process has a great future before it.

The work is furnished throughout with illustrations of plant drawn to scale, and under every operation we find statements of the expense given from actual practice.

The utility of the book is beyond all question, and we feel confident that it will be welcomed by metallurgists on both sides of the Atlantic.

CORRESPONDENCE.

WARNING TO CHEMISTS.

To the Editor of the Chemical News.

Sir,—I shall be obliged if you will call the attention of chemists to an impostor who is travelling from place to place and obtaining money under false pretences from unsuspecting chemists.

He speaks German fluently, and is evidently a German by birth, but his pronunciation is indistinct. He claims to be a chemist and a Ph.D., and states that he is out of employment and hard up.

He is of average height, and inclined to be slender; his complexion is fair, and he has a short moustache, but no beard. His eyes are deep set and half closed, and he claimed to have lost his spectacles when he called upon me. He wore then dark grey striped trousers, a long light brown jacket, and a shabby black felt hat.

From information I have obtained he appears constantly to produce a pawn-ticket, which he offers to sell. He showed me two, one of a gold watch and albert pledged n Glasgow, and the other for an overcoat pledged in this locality, to obtain money for his previous night's lodging.

He seems to have travelled a good deal in the neighbourhood of Glasgow and Edinburgh, and imparts a vast amount of information regarding chemists, chiefly Scotch, for the most part *false*.—I am, &c.,

Ph.D., F.I.C.

The Pure Culture of Yeast.—Dr. Hansen.—The author insists on the culture and use of a pure ferment.—*Moniteur Scientifique.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cv., No. 24, December 12, 1887.

On the Various Modes of the Explosive Decomposition of Picric Acid and of Nitro-compounds.—M. Berthelot.—The author describes the variety of the modes of decomposition of the nitro-compounds, properly so-called, and how they depend on the initial temperature of the decomposition. In cases where the surrounding medium presents a mass large enough to absorb the heat as it is produced, there ensues neither deflagration nor detonation. However, if a nitro-compound, such as picric acid, when burning in the air in a large mass, heats the side of the vessel to such a degree that deflagration commences, this may contribute to raise still further the temperature of the recipient, and the phenomenon is sometimes ultimately converted in detonation. If this takes place at one isolated point, as in a fire, or by the local overheating of a boiler or other apparatus, an explosive wave is generated, and is propagated by influence through the entire mass, producing a general explosion.

Compressibility of the Watery Solution of Ethylamine.—F. Isambert.—(See p. 13).

Fermentable Glyceric Aldehyd.—E. Grimaux.—It results from the author's researches that oxidised glycerin yields a glyceric aldehyd which possesses the property of undergoing the alcoholic fermentation. This is the first time that a fermentable sugar, presenting the same reactions as glucose, has been obtained synthetically. The definition of the fermentabie sugars must be modified now they are not necessarily carbohydrates containing C_6 or C_2.

Action of Sulphuric Acid and Oil of Turpentine.—G. Bouchardat and J. Lafont.—The product of this reaction is not terebene or inactive camphene, as this compound is formed by the decomposition of a sulphuric compound, not yet described.

Attempt at the Diagnosis of the Volatile Alkaloids.—Oechsner de Coninck.—The author proposes to combine a known weight of the alkaloid with the calculated quantity of methyl or ethyl iodide. The solid compound formed is then dissolved in a slight excess of absolute alcohol, the solution is heated slightly and mixed, drop by drop, with a lye of potassa at 45°. Different portions of the iodoethylate or iodomethylate are then variously treated, being, amongst other reactions, converted into chloroplatinate and chloraurate.

Detection of Aldehyds in the Alcohols of Commerce.—U. Gayon.—(See p. 13).

Moniteur Scientifique, Quesneville. Series 4, Vol. i., September, 1887.

Manufacture and Adulteration of Beer.—F. Schwackhofer.—The author gives a formidable list of adulterants, ranging from pure water, gaseous water, extract of liquorice, and glycerin, to worm-wood, gentian aloes, picric acid, strychnine, brucine, quinine, and colchicum. The use of these latter substances he regards as doubtful. The caramel employed as a colouring-matter is generally obtained, not from cane-sugar, but from glucose. The use of such caramel should, in the author's opinion, be prohibited.

Bacteria in Breweries.—H. Fischer.—The author who speaks of bacteria alternately as plants and as animals, enumerates the following species as occurring in breweries; *Bacterium lacticum*, *B. aceti*, *B. pastorianum*,

Clostridium butyricum, *Micrococcus ureæ*, *Crenothrix Kuhniana*, and *Beggiatoa alba*. The last mentioned of these organisms is nothing other than sewage fungus.

New or Improved Methods of Determining Organic Substances by Means of Potassium Permanganate.—J. H. Smith.—From the *Journal Society Chemical Industry*.

Use of Nitroso-β-Naphthol for the Separation of Different Metals.—G. von Knorre.—The author, in conjunction with M. Ilinski, described a method for separating cobalt from nickel and iron from aluminium, founded upon the use of nitroso-β-naphthol. E. Breutel has verified the accuracy of the method, and recommends it warmly. Since then the author has extended his researches. Nitroso-naphthol precipitates the acetic solutions of cobalt, iron, and copper, whilst aluminium, lead, cadmium, calcium, magnesium, manganese, nickel, mercury, and zinc remain in solution. To separate the first three metals from the others he proceeds as follows:—The solution containing the metals as sulphates or chlorides and reduced, if needful, to a small volume, is treated with ammonia in slight excess and then re-acidified by adding hydrochloric acid, drop by drop, until the precipitate formed by the ammonia has disappeared. The liquid is then heated to 90° to 95°, and an excess of nitroso-β-naphthol dissolved in acetic acid at 50 per cent is then added at the same temperature. It is convenient to pass the hot solution of nitroso-naphthol through a small dry filter and let it drop directly into the liquid to be precipitated. If cobalt alone has to be precipitated there is no occasion to attend to the acidity of the liquid, which does not in the least interfere with the precipitation. If the solution contains much alumina it is better to precipitate in the cold to avoid the separation of basic aluminium acetate. For this purpose we add to the solution half its volume of acetic acid at 50 per cent, and then an excess of the nitroso-naphthol reagent. For small quantities of alumina we may operate in heat, taking the precaution to acidulate with acetic acid, as already said. To ascertain that an excess of nitroso-naphthol has been added we receive a drop of the precipitate in a watch-glass and add a drop of a solution of cobalt. The formation of cobalti-nitroso-naphthol (purple) at once indicates the excess of the reagent. At least 1 grm. of nitroso-naphthol is required to precipitate 0·1 grm. of iron. After standing for some hours in the cold the precipitate is collected and washed with cold water until a drop of the filtrate no longer leaves a residue upon platinum foil. The dried precipitate with the filter is introduced into a roomy porcelain crucible, previously tared, which is covered loosely and heated at first very moderately, either on the sand-bath or on a sheet of iron, until vapours no longer escape. The heat is then gradually raised, and we finish with a strong ignition until all the organic matter is burnt off. The iron is then weighed as Fe_2O_3. Cobalt, after ignition, is heated to redness in the usual manner in a current of dry hydrogen. For separating and determining mixtures of iron and alumina or chromium we make up the liquor to a known volume, and in an aliquot part of it we determine the iron as above. In another aliquot portion we determine the mixed oxides by precipitating with ammonia in the usual manner. The weight of the alumina or chrome is then found by deducting the iron from the mixed oxides.—(*Chemische Industrie*).

Aniline Colours Soluble in Benzene.—A. Müller-Jacobs.—The precipitates formed by metallic salts (alum, zinc sulphate, &c.) in the solutions of resin soaps carry down with them any colouring-matters which exist dissolved in the liquid at the same time as the soap. This is particularly applicable to basic coal-tar colours, forming coloured metallic soaps, aluminium, or zinc resinates, which dissolve along with their colour in neutral solvents such as benzene, chloroform, ether, and carbon disulphide, and may serve for colouring oil-varnishes, solutions of caoutchouc, &c.

Industrial Preparation of Diphenylamine Blues.—Dr. Paul Schoop.—This valuable paper does not admit of useful abridgment.

MISCELLANEOUS.

University College, Aberystwith.—Dr. H. Lloyd Snape has been elected to fill the Chair of Chemistry rendered vacant by the lamented death of Prof. Humpidge. The new Professor acted for three sessions as Demonstrator of Chemistry at University College, Liverpool. He then resigned this appointment in order to study at the Universities of Berlin and Goettingen, under the direction of Professors Hofmann and V. Meyer respectively. Returning to England he was appointed Director of the Department of Pure and Applied Chemistry in the Manchester Technical School, one of the largest and most successful of such institutions. He possesses the diplomas of D.Sc. (Lond.) and of Ph.D. (Goettingen). Papers describing the results of his investigations of the action of phenyl cyanate upon alcohols and phenols, and of the nature and method of preparing certain cyanates and urethanes, have appeared in the Journals of the English and German Chemical Societies.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Bell Scholarship.—(Reply to "Inquirer.")—Apply to the Secretary, Pharmaceutical Society, 17, Bloomsbury Square, London, W.C.—G. A. Keyworth.

MEETINGS FOR THE WEEK.

Monday, 16th.—Medical, 8.30.
Tuesday, 17th.—Institution of Civil Engineers, 8.
— Pathological, 8.30.
— Society of Arts, 8. "The Colonies and Dependencies of the Netherlands," by A. J. Trendell, C.M.G.
— Royal Institution, 3. "Before and After Darwin," by George John Romanes, F.R.S.
Wednesday, 18th.—Society of Arts, 8. "Methods of Taking the Ballot," by John Leighton, James Withers, and John Imray.
— Meteorological, 7. (Anniversary).
Thursday, 19th.—Royal, 4.30.
— Royal Society Club, 6.30.
— Royal Institution 3. "The Walker School," by Hubert Herkomer, M.A., A.R.A.
— Chemical, 8. "On Morindon," by T. E. Thorpe, F.R.S., and W. T. Smith, M.B. (Lond). "Manganese Trioxide," by T. E. Thorpe, F.R.S., and F. J. Hambly. "Contribution to the Theory of the Vitriol Chamber Process," by Prof. Lunge. "Studies in Coal Distillation," by Lewis T. Wright.
Friday, 20th.—Royal Institution, 5. "Diffraction of Sound," by the Right Hon. Lord Rayleigh.
Saturday, 21st.—Royal Institution, 3. "Experimental Optics," by the Right Hon. Lord Rayleigh.

UNIVERSITY COLLEGE, BRISTOL.
CHEMICAL DEPARTMENT.

Professor—SYDNEY YOUNG, D.Sc.
Lecturer—ARTHUR RICHARDSON, Ph.D.

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THE CHEMICAL NEWS.

Vol. LVII No. 1469.

THE EXHAUSTION OF VIRGIN SOILS IN AUSTRALASIA.

By R. W. EMERSON MACIVOR, F.I.C., F.R.G.S., F.C.S. &c., Late "Sir William Clarke" Lecturer on Agricultural Chemistry, Victoria, and Principal of the Agricultural Department, Technical College, Sydney. N.S.W.

During the past twelve years I have had ample opportunity for studying, in more than a mere general way, the exhaustion of virgin soils in the Australasian colonies, and, as the only chemist who has systematically investigated the subject at all, perhaps the following short summary of my views may have an interest for scientific agriculturists in the Old World. I hope to publish, in a few months' time, a mass of analytical and practical data in proof of the general statements to which I am here compelled to confine myself.

It is of course well known, even in this country, that large tracts of once very productive land in South Australia, Victoria, and New South Wales, have in comparatively few years become more or less impoverished by the continuous growth, year after year, of wheat, and wheat only. In some cases the areas which, in former years, freely gave an average of 25 and 30 bushels of grain per acre, have become so poor that—even after naked fallowing for a season—they refuse to yield crops which will meet the cost of cultivation.

The light friable soils, derived from one geological formation only or from several formations, which cover vast extents of country in each colony, though usually rich enough in the cineral (or mineral) consituents of plant-food, are, except when in moist and sheltered places, singularly deficient in the rich nitrogenous humus which is the main cause of the high fertility of otherwise good land. If this deficiency is not very apparent when the ground is in a virgin state, it becomes so soon after it has been cleared and put under cultivation in the usual primitive fashion. In a lesser degree the want of humus is very noticeable in soils which are of heavier character, and generally traceable to the lower and upper silurian formations, and to the primitive rocks. The rich, deep, red and dark chocolate soils derived from the basaltic and volcanic rocks are not wanting in any of the cineral elements of plant-nourishment, and contain in their virgin state a much larger store of humus than soils of any other kind.

Speaking generally the soils of New Zealand, Tasmania, and the cooler parts of Australia contain more nitrogenous vegetable matter, or rather total nitrogen, than soils of the same formation existing where there is comparatively little rain, and, for the great part of the year, a high temperature.

I may at once state that the exhaustion of the wheat areas is due, with few if any exceptions, to the more or less complete removal of the supplies of nitrogen originally present in the soil chiefly as a constituent of humus.

The ordinary systems of farming followed in the wheat districts, in each of the three Australian colonies under notice, certainly do not tend to economise the soil-nitrogen. The ground is rarely ploughed deeper than 2½ or 3 inches, and the continued passage of the sole of the plough at this depth, season after season, ultimately causes the formation of a compact "pan" at the bottom of the furrows, which is more or less impenetrable to roots of the plants. Hence the naturally deep-rooting wheat is sooner or later made to live as a "surface feeder" in the thin layer of tilled soil resting on the compacted subsoil. In localities where the soil is at all "clayey"—as when of silurian or granitic origin — this "pan" becomes almost rock-like in hardness, and examination will often show that it has been penetrated by the roots of the cereal only to a very small extent. Now the repeated turning up of the mere surface of the ground, particularly when it is light and friable in character, to the hot dry atmosphere which prevails for most part of the year in all the great wheat areas, not only keeps the soil too dry, but causes the speedy oxidation of the humus and a consequent waste of nitrogen. It is by no means uncommon to find a greater proportion of humus in the undisturbed subsoil than in the soil which has been frequently turned over by the plough. But this is not the only way in which the amount of nitrogenous humus is reduced in the soils. In many places in Victoria, and in all the cereal growing districts of South Australia, the wheat crops are not harvested in the ordinary way, but are only "stripped" of the ears and the straw burnt where it grew. This seemingly ruinous, but unavoidable, system must certainly diminish the nitrogenous humus in the surface soil, and thereby hasten infertility.

Numerous arguments in support of my belief are deducible from the results of field experiments made at my suggestion, or under my immediate direction, in many different places, and from the experiences of hundreds of intelligent farmers; but the limited space at my disposal will not permit of my enumerating them to the extent that I should like. One or two points may, however, be referred to:—(1) It has been found that soils poor in humus are sure to give thinner crops than those of the same formation in which humus, and therefore nitrogen, occurs in fair quantity. (2) It is the general practice, in most places, to throw land which shows indications of exhaustion into naked fallow, and the original fertility is certainly in part restored by the operation, but after some years—and particularly where the soil is of light quality—the benefits of fallowing become less marked, owing, in my opinion, to the loss of humus, and therefore of nitrogen. (3) The liberal use of non-nitrogenous fertilisers has been tried on the impoverished soils of Victoria, South Australia, northern New Zealand, and Tasmania, without good effect on the yield of the wheat-crop, for which it was put into the land. In the first-named colony I have known over 1000 tons of first-class phosphatic guanos—non-nitrogenous or nearly so—to be used in one year, on all classes of impoverished ground, without the wheat-crops being, even in a single instance, perceptibly benefited either in quantity or quality. Neither had non-nitrogenous superphosphate, even when containing 28 per cent soluble phosphate, any very marked influence on the crops. Potash, as sulphate and as chloride, either separately or in conjunction with superphosphate, also gave negative results. Top-dressings of nitrate of soda invariably improved the yield of both grain and straw, but never to the extent of giving a substantial profit on the outlay. Sulphate of ammonia, blood manure, bone-dust, and ammoniacal guanos, each gave a more or less satisfactory return according to the quantity and form of nitrogen it contained. (4) Experience in the West-Bourke district, in Victoria, has proved that an occasional pea crop is a sure restorer of fertility to an impaired wheat soil. It is well known to everybody who has the most rudimentary knowledge of farming that leguminous crops are good precursors of wheat in a rotation, and that beans and red clover are the best of these. In Australia neither of the latter is known as a general field crop; indeed red clover does not thrive at all,—in fact does not seed, though in places it yields abundance of flowers,—but in the Mata Mata district, in northern New Zealand, Mr. J. C. Firth has, after much praiseworthy effort and a great outlay of time and money, succeeded in extensively introducing red clover as a preparatory crop for wheat. In the West Bourke district peas is the crop which has for many years been sown as a precursor for the cereal, and the results have been so eminently successful that the practice has been adopted

in many localities throughout those parts of each colony where the markets and other circumstances have proved favourable to its being followed. The increased yields of grain obtained after peas can only be attributed to the large quantity of nitrogen in the form of root-residue and fallen leaves which are left in the soil for the use of the wheat.

In concluding this short paper on a great subject I may say that many of the diseases that have afflicted, and still afflict, the wheat and other graminaceous crops throughout Australia have been foolishly set down to the exhaustion of the soil in one or other of the constituents of plant-food. Thus "red-rust" is often attributed to this cause, as also has been the red fungus which attacks the sugar-cane in some parts of New South Wales and Queensland. Now, as a matter of fact, both these forms of fungi do most harm where the crops are most luxuriant, and therefore where the soils are richest. To my certain knowledge thin wheat crops, growing on naturally poorish or impoverished ground, are least troubled with "red-rust."

THE ACTION OF

SULPHUR AND SULPHUR CHLORIDE ON OILS.

By THOMAS T. P. BRUCE WARREN.

I PROPOSE to consider the historical bearing of this interesting subject, more especially as I find under the article "Linseed Oil" ("Watts's Dictionary," vol. iii., p. 703) a few important statements which as they stand are misleading, or at least require supplementing.

Alexander Parkes, in 1846, took out a patent for vulcanising india-rubber, by what is now known as the "cold curing process." As the "curing" or "vulcanising" is confined to the surface of rubber goods, it is more correctly called "surface curing." In the same patent he claimed the action of these "changing agents" on animal and vegetable oils. In a disclaimer he abandoned the parts contained in his provisional specification relating to animal oils. I shall return to this on a future occasion. "On mixing 15 to 25 parts *chloride of sulphur* with 100 parts linseed oil, caoutchouc-like products are obtained, which are the harder the more chloride of sulphur they contain, and are not attacked by moderately dilute acids and aqueous alkalies, but are ultimately saponified by concentrated alkalies. They become brown at 120° C., and blacken and melt at a higher temperature. The addition of 5 per cent chloride of sulphur thickens linseed oil, but does not cause it to harden; the product still retains the solubility of the fatty oils. When to a solution of 1 part linseed oil in 30 or 40 parts carbon disulphide, a quantity of chloride of sulphur is added equal to one-fourth the weight of the oil, the mixture remains fluid for some days, and dries to a varnish on wood." (Perra, *Comptes Rendus*, xlvii., 878; see also *Comptes Rendus*, xlvii., 972).—"Watts's Dictionary," Art. "Linseed Oil," *supra*.

Now a very great deal will depend on what the sulphur chloride itself is, the temperature at which it is mixed with the oil, and also the solvent with which the chloride is mixed. If a large quantity of carbon disulphide be used, or any easily volatile solvent on which the chloride has no action, it is a mere matter of expelling the solvent; as soon as a certain degree of concentration is reached it acts, with a rise of temperature, which facilitates its action and expels the solvent. If a solvent be used with a high boiling-point, the action of the chloride *seems* to be arrested, or modified, even if a substance be present on which the chloride will act in an ordinary way, as on linseed oil. The addition of a small quantity will thicken linseed oil, which thickening is due to the altered oil dissolving in the unaltered oil; but if the oil *perfectly acted on*, so as to yield a solid product, be added to any quantity of oil it does *not* dissolve.

In applying this agent as a quantitative test for oils of this class (drying oils), which may be mixed with a large quantity either of a non-drying oil or animal oil or fat, as well as vegetable fats, I add a certain quantity of a known oil, so that the drying oil present, *plus* the added oil, will be relatively large, compared to the amount of non-drying oils, &c.

A drying oil, under the same conditions and applying the reagent in the same way, will yield the same quantity of solid, non soluble product; when treated with carbon disulphide, this solvent will remove also uniform quantities of extracted matters, oils, &c.

Turpentine, rosin oils, or mixtures of these, are acted on in the same way; a high-boiling petroleum does not even retard the action. When these are mixed with drying oils they can be separated from them after the action of the chloride, as their products are quite soluble in carbon disulphide: this liquid is preferable to petroleum spirit for this purpose, as it exerts a greater softening action on the oil product. I have still this important reaction under consideration, which I hope to refer to at a future time in connection with adulterations of turpentine.

The addition of an excess of sulphur chloride to an oil will give a smaller yield of solid product than if such excess be avoided. We here meet with a difficulty which can be to a very great extent avoided if we have a fair idea of the oil we are operating on, but if we have not it is best to add a few drops of chloride to the disulphide extract, evaporate, and treat as before, avoiding, in such cases, a large excess, especially at first.

When dealing with a mixture of two oils, each of which give solid products, an approximation may be made as to the proportion of each oil present, which should be verified by careful experiment on known mixtures of these oils.

A few facts have already been revealed which establish the value of this reagent; amongst others, I find that lard oil is now largely met with which does not contain lard in any form. Olive oil is most fraudulently dealt with; in many cases adulteration is not even attempted, but it is simply substituted by another oil. Lucca oil is, with no disguise, a product of Hull manufacture. Colza oil is met with which does not contain oven one-third part refined rape oil. Turpentine is disgracefully adulterated with a mixture of rosin oil and petroleum, which is so ingeniously made that the fractions from these with turpentine give a mixture closely agreeing in density and boiling-point with pure turpentine. Even lard itself is frequently met with which contains vegetable stearines obtained in the manufacture of oleo-margarine.

Genuine lard oil is not affected so as to yield a solid product; it is a common thing to obtain a perfectly solid product from American lard oil. English oil is almost as bad. The colour of the American product, after washing with disulphide, shows that it is the same oil which is sometimes offered as almond oil; most probably it is a mixture containing arachis oil; vegetable stearines are added to produce thickening.

These solid products vary in colour with each oil, the conditions even of the same oil, where marked alterations are visible, give corresponding and highly characteristic products; thus the "blown" rape oils and cotton oils are at once detected from ordinary rape, colza, or refined rape oil or ordinary cotton oil; rape oil, poppy oil, and others are recognised without difficulty.

Castor oil, as supplied for lubricating is an interesting but curious compound. Does this article, as well as the olive oil, find their way into pharmacy?

I give a few results obtained with some of these oils, and hope to supplement this with others in my next:—

Colza Oil, 5 grms. 1 c.c. chloride, diluted with CS_2.

Sample A yielded 6·320 grms.
" B " 6·325 " Product white.

Rape Oil, same as Colza oil.

Sample A yielded 6·235 grms. } Mean 6·208; products
" B " 6·301 " } white.

Blown Rape Oil, same as above.

Sample A yielded 6·070 grms. } Mean 6·095; products
" B " 6·120 " } dark, almost black.

Linseed Oil, 5 c.c. oil and 5 c.c. chloride, with CS_2

Sample A yielded 6·990 grms. }
" B " 7·021 " } Mean 7·035; products
" C " 7·095 " } dark.

These are ordinary results, without special precautions, and obtained with oils delivered some months apart. I have used this reagent for nearly twenty-five years, and have never found reason to suspect its accuracy.

THE DETERMINATION OF CARBON IN STEEL.

By BERTRAM BLOUNT.

TOWARDS the close of 1884 I had occasion to determine the carbon in a sample of steel, which, when treated by the ordinary plan of solution in cupric sulphate, went up very slowly.

Having also tried the electrolytic method without much success (owing perhaps to the form in which the metal was, viz., turnings), I strove to devise some process that should fulfil the requirements of such cases as that with which I was dealing.

It occurred to me that it might be feasible to estimate the carbon in a steel by dissolving the metal in dilute acid, passing the evolved gases over red-hot copper oxide and weighing the CO_2 produced. I was at the time unaware that the very same plan had been recommended by Fresenius (*vide* Crookes's "Select Methods," 2nd edit., p. 145), so that I then regarded my work as original,—nor did this information reach me until after the completion of the investigation.

I will at once say that in my hands the method was a failure, for a reason that will be stated below; but the recording of failures is not wholly useless, even if only to point out the whereabouts of a "No Thoroughfare."

The apparatus used was as follows, and was placed in the order given:—

(1) A gasholder containing nitrogen.

(2) A wash-bottle of caustic potash, to free the nitrogen from traces of CO_2.

(3) The flask in which the steel was dissolved. This was provided with a three-holed cork carrying a tap-funnel for the introduction of the acid, an inlet tube for the nitrogen, and an outlet for the gases evolved by the solution of the steel.

(4) Some simple arrangement for condensing the steam given off on boiling the contents of the flask at the close of the operation, and either returning it to the flask or catching it in a bulb or U-tube.

(5) A calcium chloride tube.

(6) A piece of combustion tube, 6 or 8 inches long, filled with copper oxide, and heated by a small furnace.

(7) An empty U-tube, to catch most of the water formed by the oxidation of the hydrogen—free and combined—given off by the solution of the steel in the acid.

(8) A calcium chloride tube to complete the removal of the water mentioned in (7).

(9) A weighed potash bulb and drying tube, for the collection of the CO_2.

(10) A guard tube.

The following was the method of procedure:—

A weighed quantity—generally about 6 grms.—of the steel was placed in the flask, the tube of copper oxide heated to redness, the potash bulb weighed and attached, all joints ascertained to be tight, and then nitrogen passed briskly through the whole apparatus until the air was judged to have been expelled.

The flow of nitrogen was then almost stopped and about 70 c.c. of dilute sulphuric acid, 1 : 4 by vol., run in through the tap-funnel on to the steel.

The evolution of gas went on steadily, and, when it showed signs of slackening, was aided by gently warming the flask.

When solution was complete the flow of nitrogen was increased, and the contents of the flask boiled for some minutes.

The potash bulbs were then disconnected and weighed.

The solution generally took about two hours, though in the later experiments this time was reduced to but little over an hour without difficulty.

The heating and passing of nitrogen occupied another twenty or thirty minutes.

The insoluble matter in the flask was of course carbonaceous, and the carbon it contained was in all cases determined by the chromic acid method.

In the first set of experiments a steel which we will call A was used.

The results were not concordant, and were without exception lower than the percentage given by Ullgren's method, as the appended Table will show:—

Results with Steel A.

	Parts per cent.		
	Carbon as gaseous Hydrocarbons.	Carbon left as an insoluble residue.	Total Carbon.
Ullgren's method ..	—	—	0·687
Method now on trial:—			
Determination 1 ..	0·512	0·079	0·591
" 2 ..	0·611	0·071	0·682
" 3 ..	0·487	0·091	0·578
" 4 ..	0·433	0·032*	0·465

A piece of cast-steel, B, containing a larger percentage of carbon (tool-steel) was made the subject of another set of experiments.

The results were also discordant, and showed a tendency to be lower than the truth.

Results with Steel B.

	Parts per cent.		
	Carbon as gaseous Hydrocarbons.	Carbon left as an insoluble residue.	Total Carbon.
Ullgren's method ..	—	—	1·169
Method now on trial:—			
Determination 1 ..	0·902	0·098	1·000
" 2 ..	0·979	0·207	1·186†
" 3 ..	0·875	0·064	0·939

I attribute the irregularity which characterises both sets of results to the formation of liquid hydrocarbons, varying in quantity according to slight differences in the temperature or rate of solution, which hydrocarbons escape, (partially at least), being carried on by those which are gaseous and subsequent oxidation by the copper oxide, and, on the other hand, are filtered off from the solid carbonaceous residue in the flask, and therefore also escape oxidation in the final treatment with chromic acid.

A greater measure of success might probably be attained by boiling off most of the water in the flask after solution had been effected, and—instead of condensing it—leading it through a tube kept slightly above 100°, so as to retain it all as steam, and in that state allowing it to enter the copper oxide tube, bearing with it the less volatile hydrocarbons.

I may remark, with regard to any method which is based

* In this instance the residue was washed with water, alcohol, ether, alcohol, and water, in the order named, to remove any liquid hydrocarbons, which may account for the low result.

† I cannot account for this high result.

on the solution of the steel in cupric sulphate, that the rate of solution is increased, and the deposit of copper which is left with the carbonaceous matter materially diminished, by the following simple plan:—

A weighed portion of the steel is placed on a platinum plate, at the bottom of a beaker containing the usual solution of cupric sulphate, and is connected with the + pole of one or two Daniell cells.

The other pole is connected with a copper plate which is suspended in the beaker a short distance above the pieces of steel.

As the steel dissolves in the cupric sulphate and throws down copper, so is that copper by the action of the current, re-dissolved, carried across to the cathode and deposited there. By keeping the current rather smaller than is necessary to remove the copper as fast as it is deposited, all risk of oxidising the carbon is obviated.

The carbon is finally left mixed with only a small quantity of copper, so that its removal by cupric chloride before oxidising by chromic acid (if that method be employed) is rendered unnecessary, thus materially saving time and labour.

The principle of the method is identical with that known as Weyl's, but it has two not inconsiderable advantages:—

(i.) That a tedious adjustment of the current so as to avoid oxidation of the carbon, on the one hand, and escape of gaseous hydrocarbons on the other, is not required; and—

(ii.) That the form in which the sample exists is almost a matter of indifference.

I hope to publish shortly a few results bearing on the composition of the gaseous hydrocarbons which are evolved by the solution of steel in dilute sulphuric acid.

Laboratory, Broadway, Westminster,
January 9, 1888.

METHODS OF DETERMINING POTASH.*

Method of Lindo as Modified by Gladding.

(1) *Superphosphates.*—Boil 10 grms. of the fertiliser with 300 c.c. of water for ten minutes. Cool the solution; add ammonia in slight excess, thus precipitating all phosphate of lime, oxide of iron, and alumina, &c., make up to 500 c.c., mix thoroughly and filter through a dry filter; take 50 c.c. corresponding to 1 grm., evaporate nearly to dryness, add 1 c.c. of dilute H_2SO_4 (1 to 1), and evaporate to dryness and ignite to whiteness. As all the potash is in form of sulphate, no loss need be apprehended by volatilisation of potash, and a full red heat must be used until the residue is perfectly white. This residue is dissolved in hot water plus a few drops of HCl; 5 c.c. of a solution of pure NaCl (containing 20 grms. NaCl to the litre) and an excess of platinum solution (4 c.c.) are now added, and the whole evaporated as usual. The precipitate is washed thoroughly with alcohol by decantation and on filter, as usual. The washing should be continued even after the filtrate is colourless. Ten c.c. of the NH_4Cl solution prepared as above are now run through the filter. These 10 c.c. will contain the bulk of the impurities, and are thrown away. A fresh portion of 10 c.c. NH_4Cl is now run through the filter several times (five or six). The filter is then washed thoroughly with pure alcohol, dried, and weighed as usual. The platinum solution used contains 1 grm. metallic platinum in every 10 c.c.

(2) *Muriates of Potash.*—In the analysis of these salts an aliquot portion, containing 0·500 grm., is evaporated with 10 c.c. platinum solution plus a few drops of HCl, and washed as before.

(3) *Sulphate of Potash, Kainite, &c.*—In the analysis of these salts an aliquot portion containing 0·500 grm. is taken, 0·250 grm. of NaCl added, plus a few drops of HCl, and the whole evaporated with 15 c.c. platinum solution. In this case special care must be taken, in the washing with alcohol, to remove all the double chloride of platinum and sodium. The washing should be continued for some time after the filtrate is colourless. Twenty-five c.c. of the NH_4Cl solution are employed, instead of 10 c.c., and the 25 c.c. poured through at least six times to remove all sulphates and chlorides. Wash finally with alcohol, dry, and weigh as usual.

To prepare the washing solution of NH_4Cl, place in a bottle 500 c.c. H_2O, 100 grms. of NH_4Cl; shake till dissolved. Now pulverise 5 or 10 grms. of K_2PtCl_6, put in the bottle, and shake at intervals for six or eight hours; let settle over night; then filter off liquid into a second bottle. The first bottle is then ready for a preparation of a fresh supply when needed.

Alternate Method.

Pulverise the fertiliser (200 or 300 grms.) in a mortar; take 10 grms., boil for ten minutes with 200 c.c. water, and after cooling, and without filtering, make up to 1000 c.c., and filter through a dry paper. In this method, in case the potash is contained in organic compounds, like tobacco stems, cotton-seed hulls, &c., the substance is to be saturated with strong sulphuric acid and ignited in a muffle to destroy organic matter. If the sample have 10 to 15 per cent K_2O (kainite), take 50 c.c. of the filtrate; if from 2 to 3 per cent K_2O (ordinary potash fertilisers), take 100 c.c. of the filtrate. In each case make the volume up to 150 c.c., heat to 100°, and add, drop by drop, with constant stirring, slight excess of barium chloride; without filtering, in the same manner, add barium hydrate in slight excess. Heat, filter, and wash until precipitate is free of chlorides. Add to filtrate 1 c.c. strong ammonium hydrate, and then a saturated solution of ammonium carbonate until excess of barium is precipitated. Heat. Add now, in fine powder, 0·5 grm. pure oxalic acid or 0·75 grm. ammonium oxalate. Filter, wash free of chlorides, evaporate filtrate to dryness in a platinum dish, and, holding dish with crucible tongs, ignite carefully over the free flame below red heat until all volatile matter is driven off.

The residue is now digested with hot water, filtered through a small filter, and washed with successive small portions of water until the filtrate amounts to 30 c.c. or more. To this filtrate, after adding two drops of strong hydrochloric acid, is added, in a porcelain dish, 5 to 10 c.c. of a solution of 10 grms. of platinic chloride in 100 c.c. of water. The mixture is now evaporated on the water-bath to a thick syrup, or further treated with strong alcohol washed by decantation, collected in a Gooch crucible or other form of filter, washed with strong alcohol, afterwards with 5 c.c. ether, dried for thirty minutes at 100° C., and weighed.

It is desirable, if there is an appearance of white foreign matter in the double salt, that it should be washed, according to the previous method, with 10 c.c. of the half-concentrated solution of NH_4Cl, which has been saturated by shaking with K_2PtCl_6, as recommended by Gladding.

The use of the factor 0·3056 for converting K_2PtCl_6 to KCl and 0·19308 for converting to K_2O is continued.

* Official Methods of Analysis of the Association of Official Agricultural Chemists for 1887-88. U.S. Department of Agriculture, Division of Chemistry.

Influence of Molecular Approximation on the Chemical Equilibrium of Homogeneous Gaseous Systems.—MM. Sarrau and Vieille.—Many organic explosives do not contain sufficient oxygen to ensure the complete combustion of their elements. The reaction of decomposition then gives rise in many cases to an equilibrium among the exclusively gaseous products. Experiment shows that this final equilibrium is modified if the weight of the explosive is progressively increased so as to submit the decomposition products to increasing pressures, differing among themselves by several thousand atmospheres.—*Comptes Rendus*, Vol. cv., No. 25.

VALUATION OF INDIGOES.

AN INVESTIGATION INTO THE VARIOUS METHODS EMPLOYED FOR THE ESTIMATION OF INDIGOTIN, TOGETHER WITH CERTAIN NEW AND MODIFIED PROCESSES.*

By CHRISTOPHER RAWSON, F.C.S.

(Continued from p. 20).

Hyposulphite Method.—This process, which was recommended by A. Müller (*American Chemist*, v., p. 128), depends upon the fact that a solution of sodium hyposulphite reduces sulphindigotic acid quantitatively to disulpho-leukindigotic acid. In speaking of sodium hyposulphite I do not allude to the "hyposulphite" of the photographer, which is really sodium thiosulphate ($Na_2S_2O_3$), but to the sodium salt derived from the true hyposulphurous acid, H_2SO_2. The apparatus required for this operation is perhaps rather elaborate, and considerable care must be exercised in its manipulation; but when all the details are carried out analyses may be performed in a short space of time with very great accuracy. I will describe the method as performed in my own laboratory, though it only differs from Müller's account in a few details, which considerable practice has, in the course of time, led me to adopt with advantage.

1. *Preparation of Sodium Hyposulphite.*—A flask of about 100 c.c. capacity is loosely filled with twisted sheet zinc, which is covered with a solution of sodium bisulphite (sp. gr. 1·30). The flask is corked and allowed to stand for about an hour, when the bisulphite will be found to have lost the smell of sulphurous acid. The liquid is now decanted and well-mixed in a large flask or bottle, with five litres of distilled water, containing in suspension about 50 grms. of recently slaked lime. The vessel is closed to prevent access of air, and, after allowing the insoluble matters to subside, the clear liquid is syphoned off into a convenient store bottle, and about 100 c.c. of petroleum oil are poured on the surface of the liquid to prevent oxidation. The bottle is provided with a cork through which pass two tubes, one of which is in the form of a syphon, and is used to fill the burette; the other tube, which only just passes through the cork, is connected with a supply of coal-gas. A further precaution which I employ in order to preserve the strength of the hyposulphite solution is to cover the bottle with a sheet of black paper.

2. *Standardising the Hyposulphite.*—The solution may be standardised either by pure indigotin or by an ammoniacal solution of sulphate of copper, using, in the latter case, a solution of indigo-carmine as an indicator. Bernthsen pointed out in 1881 (CHEMICAL NEWS, xliii., p. 79) that ammoniacal sulphate of copper alone could not be used for estimating the strength of a solution of sodium hyposulphite, as the solution of sulphate of copper became colourless before it was completely reduced. On this account he proposed that, towards the end of the titration, a few drops of indigo-sulphate solution should be added, by which modification the termination of the reaction could be easily and accurately ascertained. Müller found in his experiments that one molecule of ammoniacal sulphate of copper was decolourised by the same quantity of "hyposulphite" as one molecule of indigotin dissolved in sulphuric acid. My own estimations confirm this statement. The standard solution of copper sulphate is prepared by dissolving 1·904 grm. (equal to 1 grm. indigotin) of the crystallised salt ($CuSO_4.5H_2O$) in a litre of water containing 100 c.c. of strong ammonia (sp. gr. 0·880); 50 c.c. of this solution are measured into a wide-mouthed flask (capacity 200 c.c.), boiled to expel air, and allowed to cool. The flask is provided with a caoutchouc stopper, perforated with four holes, into two of which are fitted two Mohr's burettes, one containing the hyposulphite solution, and the other the indigo-carmine. The two other apertures serve for the entrance and exit of a current of hydrogen or coal-gas. It is essential that the process should be conducted without access of air. The burette containing the "hyposulphite" is furnished with a perforated cork, through which passes a glass tube connected with a supply of coal-gas; and at the lower extremity a glass tube is joined to it, which is in connection with the bottle filled with sodium hyposulphite above mentioned. By this means the burette can be refilled without fear of oxidising the hyposulphite solution. The flask containing the 50 c.c. of copper sulphate is attached to the caoutchouc stopper, and the air is expelled by a current of coal-gas, which should first pass through U-tubes containing ferrous hydrate. The solution of "hyposulphite" is now gradually run in until the liquid becomes nearly colourless, when a few drops of indigo-carmine are added from the other burette, and finally, a further quantity of hyposulphite is added, until the solution assumes a peculiar brownish-red colour. The end of the reaction is sharp and unmistakable. The quantity of hyposulphite which is used to decolourise the few drops of indigo-carmine solution is very small, but by determining the relative strength of the two liquids the amount thus consumed can be easily calculated, and then deducted from the number of c.c. used in the titration of the copper sulphate solution. The 50 c.c. of copper sulphate are equivalent to 0·05 indigotin, so that supposing 25 c.c. of sodium hyposulphite have been required for the titration, each c.c. of the hyposulphite will correspond to 0·002 indigotin.

3. *Titration of Indigo-Sulphate.*—The operation is performed in a similar manner to that just described. From 0·75 to 1·25 grm. of finely-powdered indigo is mixed with ground glass and dissolved in sulphuric acid as previously stated in detail. The sulphindigotic acid is diluted to 1 litre and filtered; 50 c.c. of the filtrate are measured into a flask, boiled to expel air, and allowed to cool. The flask is then attached to the burettes, and after driving out the air by a current of coal-gas the "hyposulphite" solution is gradually added, during constant agitation. With indigotin and the better qualities of indigo the liquid, when fully reduced, becomes of a pale yellow tint, but with inferior samples the solution is more or less of a dirty brownish-yellow colour. In both cases, however, the end of the reaction is quite clear and distinct.

Action of Sodium Hyposulphite upon the Constituents of Indigo other than Indigotin.—A series of experiments were performed similar to those described under the permanganate method. It was found that neither indigo-gluten, indigo-brown, nor indigo-red had any appreciable effect upon the estimation of indigotin by sodium hyposulphite. But there is one possible source of error. If the solution to be titrated contains iron in the ferric state, the results obtained are somewhat too high. I have made experiments with ammonio-ferric sulphate (iron-alum), and found that sodium hyposulphite reduces ferric sulphate, in an acid solution, quantitatively to ferrous sulphate. A few drops of sulphate of indigo were used as an indicator, as in standardising the hyposulphite by means of copper sulphate. I found that the same quantity of hyposulphite solution was required to reduce one molecule of ferric sulphate as to reduce one molecule of sulphate of copper. I am not aware that this reaction has been previously noticed, but it forms a quick and trustworthy direct method for the estimation of ferric iron. A standard solution of ferric sulphate may also be employed, in place of ammoniacal copper sulphate, for determining the strength of the hyposulphite solution.

It is only in the lower classes of indigo that iron is present to any appreciable extent, and in those cases it principally exists, or subsequently becomes reduced to, the ferrous state. The hyposulphite method gives the percentage of indigotin, and does not include indigo-red.

Example III.—50 c.c. standard ammoniacal sulphate of copper (= 0·05 indigotin) required 30 c.c. sodium hyposulphite—

$$\therefore \text{ 1 c.c. hyposulphite} = \frac{0{\cdot}05}{30} = 0{\cdot}00\dot{1}6\dot{6} \text{ indigotin.}$$

* *Journal of the Society of Dyers and Colourists*, No. 4, Vol. I.

1 grm. of Java indigo was dissolved in sulphuric acid and diluted with water to 1 litre; 50 c.c. (= 0·05 indigo) required 20·6 c.c. hyposulphite—

$$\therefore \frac{0{\cdot}00166 \times 20{\cdot}6 \times 100}{0{\cdot}05} = 68{\cdot}64 \text{ per cent indigotin.}$$

(To be continued).

NOTICES OF BOOKS.

Chemistry, Inorganic and Organic, with Experiments. By Charles Loudon Bloxam, Professor of Chemistry in King's College, London; in the Department of Artillery Studies, Woolwich; and formerly in the Royal Military Academy, Woolwich. Sixth Edition. London: J. and A. Churchill.

This edition of Mr. Bloxam's work derives a melancholy interest from the very recent death of the author. The publishers, in a brief note, express their regret of one whom they so highly esteemed and with whom their firm has been associated for more than thirty-four years. They feel, however, a degree of satisfaction—which we also show—that the work had been completed and revised by Professor Bloxam himself before he was seized with his last illness, "so that it is not necessary to add another name to the title-page of this edition."

"Chemistry, Inorganic and Organic," first appeared in 1866, and, notwithstanding the great number of other text-books—some of them unquestionably meritorious—which have since appeared, it has remained in favour both among students and teachers. This is indeed at once made evident from the fact that the publishers found it necessary to issue the edition before us.

The work, we find, has undergone much more than a mere revision; a large part of it has been re-written, to keep it in harmony with the recent advance of chemical science. Of course the portion devoted to organic chemistry has been most completely remodelled. In the earlier editions the composition and properties of bodies were discussed as they presented themselves in the description of industrial operations, an arrangement which rendered it difficult to bring their theoretical relations into sufficient prominence.. This is altered in the present edition. Organic bodies are classified as hydrocarbons, alcohols, aldehyds, acids, ketones, &c.

Of course in a book which does not run to 800 pages not every known compound can be treated in detail, but the descriptions have the merit of being exceedingly clear. It will be perceived that particular attention has been given to explosives, and especially gunpowder, a circumstance due to the fact of the author's long connection with military colleges.

Metallurgy occupies a space perhaps unusual in chemical manuals of the present day, since it is now ordinarily treated of in distinct works.

The most recent discoveries are duly introduced. Thus we find a notice of the isolation of fluorine, and the properties of germanium are described at some extent.

There is an exceedingly elaborate index, extending to upwards of 40 pages, as well as a table of contents. It is necessary for readers to bear in mind that in this table the references are to paragraphs, but in the index to pages.

To attempt any formal judgment on a work which has reached its sixth edition would be not merely an unnecessary but a gratuitous task; but we may safely say that, as it now stands, it is a decided improvement on the former issues, and that it will be found still more useful.

Notes on the Literature of Explosives. By Chas. E. Munroe. No. xiv.

The pamphlet now lying before us contains, amongst other matter, an account of the circumstances attending what has been called "A Remarkable Explosion," which occurred at Brighton, Ill., U.S.A., during a severe thunderstorm.

The magazine contained 50 tons of powder and 15 tons of dynamite. After giving some details of the extent of the damage, certain minor facts that bear on the general subject of explosions are stated and discussed. A consideration of these facts shows that the immediate result of the explosion was to instantly produce a large volume of gas, which crushed everything within a certain radius. The condensation of the surrounding air would naturally free itself in the direction of least resistance, that is to say, upwards, so this condition was confined to a small circle. Fortunately no other magazine, and there were ten others, was situated within this area, so the rest of the dynamite was unaffected by the shock. Beyond this area there was a narrow circle of land with a radius of about fifteen rods where comparatively little injury was done. Outside this area, the movement of the air was towards the point of explosion. This was shown to be the case by the glass in the windows of the more distant dwellings being forced outwards.

It is most remarkable that although one of these magazines was exploded by a flash of lightning in 1880, no precautions in the shape of lightning conductors had been taken; this seems to show either a total disregard of the known laws of electricity, or else a mistaken notion that the conductor attracts the lightning, and thus increases the danger, instead of providing a safe path for the current.

The problem of protecting magazines has been compared to that of the protection of tanks in which petroleum is stored; but this view is quite erroneous; in the case of petroleum tanks there is always a veil of explosive vapour of varying height hanging over and about the tank, so that the difficulty met with is to carry off the current safely before it can reach this column of ascending gas. Gunpowder magazines, on the other hand, offer no such difficulty, and it should be imperative on all owners of such buildings to have them placed under proper protection by some competent man.

Following this is an account of the trials of some new shells, in which the component parts of the explosive are placed in three separate glass vessels. A time fuse is attached, and when the projectile has travelled a certain part of its trajectory a small charge of powder breaks the glasses, and causes their contents to become intimately mixed. On striking a resisting object the force of impact causes the explosion of the compound formed. Before firing this shell is perfectly free from danger.

A note on "Unsuspected Dangers with Frictional Electricity in Blasting," gives an interesting and instructive account of an accident which occurred during some experiments in submarine mining. Two cables were employed to fire the charges, but on the word being given to fire the first mine, both exploded, although the cables were thoroughly insulated one from the other; a careful examination showed that nothing had been tampered with. So another set of experiments was instituted, and it was eventually found that the firing of the second charge was due to induction, and it was furthermore proved that it would be dangerous, on cables running parallel, and within even forty or fifty feet of each other, to employ the frictional machine where more than one charge is connected.

CORRESPONDENCE.

WARNING TO CHEMISTS.

To the Editor of the Chemical News.

Sir,—As one of the Scotch chemists referred to in the timely warning of Ph.D., F.I.C., in Chemical News, vol. lvii., p. 23, I write to say that the individual is not un-

known in Scotland. His information was doubtless derived during a somewhat prolonged tour he appears to have made here last summer. On that occasion I have proof that he visited not only many works' chemists, but lecturers, and even directors of Chemical Companies, there being no limit to his assurance. He seems to have frequently obtained money from charitable people, which on one occasion he was observed to spend on drink. Perhaps his worst characteristic is the *false* and even injurious statements he makes anent those chemists whom he professes to know. It is to be hoped that this correspondence will warn others, and enable them to hand him over to the police.—I am, &c.,

Analyst, F.I.C., &c.

ANALYSES OF MIXED PAINTS.

To the Editor of the Chemical News.

Sir,—Mr. Fox's criticisms on the method of examining paints, which appeared in the Chemical News (vol. lvi., p. 279), require that I should explain why I recommended this method.

I did not give this as a method of analysis, the results of which have to be *interpreted* in accordance with technical knowledge, but as a process applicable to any ordinary case and to every possible mixture, so far as I am aware. Although the operator may know little about paints, he can obtain results which enable him to speak with as much assurance as if he he had been trained to this business.

Nitric acid was used thirty-five years ago for this purpose, in exactly the same way as given by Mr. Fox; paints were then very different to what we find them now. To the stock in trade of a paint manufacturer we must now include benzine and other fractions of petroleum, rosin and rosin oil, shale spirit, certain metallic oleates and fatty compounds, as well as those resulting from the action of rosin acids on zinc, lead, calcic, and other oxides.

My objection to burning off the oils, &c., is the reduction and loss of lead, turpentine, *et hoc omne genus*, and the volatile compounds of arsenic and mercury. Nitric acid is not satisfactory to use; the oils are recovered in a completely altered form, from which nothing can be ascertained of their nature or previous condition; the same is obtained mixed with insoluble compounds not acted on by nitric acid, and insoluble compounds formed by the action of nitric acid; added to this we have the oxidised products of turpentine, rosin, and rosin oil, although turpentine is separately estimated from the *distilled* product.

Let us assume that this method is used where lead compounds and sulphites of zinc, &c., are present. The bases are partly converted into nitrates, and, although the results are intelligible to one who is fairly acquainted with paints, what is there to guide an outsider? For instance, calcium is found as nitrate and sulphate; the carbonate may be an adulterant of white lead, its oxide may be the base of fatty compounds, or the sulphate may be an impurity in barium sulphate, &c.

The basic oxides, in particular, will act on the oil, and the compounds so formed will dissolve in the solvents I recommend. The weight of oil and soluble fatty acids is increased by the bases combined with the acids, but a subsequent part of the process removes the bases, so that the linseed oil and fatty acids of this oil are recovered together by the sulphur chloride. If we wish to know how much linseed oil existed in combined forms, we can arrive at the same from the bases set free. Sulphur chloride acts not only on the drying oils, but it acts in a similar way on the liberated acids from these oils. The sulphur chloride decomposes the fatty salts, and the acids thus set free are acted on as so much oil, that is, *if they have been obtained from a good drying oil.*

Mr. Fox says that "the turpentine, shale spirit, or petroleum would evaporate with the solvent used for their extraction." Even if they do, which is quite problematical, there is no difficulty in providing for their recovery. Mr. Fox says "the oil is not the *body*-giving material of paints, &c." This sentence is confusing. The oil altered by the pigment is the body-giving medium; pigments alone will not give body any more than barium sulphate.

Sulphur chloride acts on turpentine, rosin, and rosin oils, and converts them rapidly into semi-solid resinous substances, but, being soluble in carbon disulphide, they can be separated from the oil. By carrying out this operation in a retort we can distil over the petroleum, which is unaltered. If rosin or rosin oil be present the action is very violent, and a similar product is obtained, but the colour is so very much darker than is given by pure turpentine that these adulterations are readily apparent.

To confirm the presence of rosin or rosin oil the residue is digested with an alcoholic solution of soda; the chloride will now give a rich ruby resin, instead of a dark, almost black, product. This test has enabled me to fix on the composition of this so-called turpentine, which is very extensively sold.

The addition of petroleum, boiling 270° to 320° F., would reveal itself by the density; hence rosin or rosin oil is added to make the mixture equal to that of turpentine.

The behaviour of this turpentine with sulphur chloride is so characteristic that this fraudulent mixture cannot deceive even an inexperienced person.

If the separation of the ingredients of a paint, as previously indicated, is not required, the process can be immensely shortened, and much information can be obtained in a few minutes of greater value than the nitric acid process can possibly give. Carbon disulphide is added to the paint or pigment ground in oil; to this sulphur chloride is added, when, if the paint is in a good drying condition, it almost instantly dries up on evaporating the disulphide. From the powdered mass—petroleum, resins (including the turpentine and rosin oil)—unaltered oil can easily be removed by carbon disulphide.

Mr. Fox speaks of the errors due to sulphur chloride on oils, &c., as fatal to its value. I am rather surprised at this statement, for an error of 5 per cent in estimating an oil is the limit allowed; it very frequently does not exceed 1 per cent between duplicate tests made on the same oil.

When two oils are mixed together, which are acted on with sulphur chloride, the weight of the product, if the oils themselves are known, will supply the means of saying how much of each oil is present in the mixture. A mixture of poppy oil and linseed oil, examined a few days ago, gave results which showed that these oils were present in equal proportions. What should we have learnt if we acted on a paint made with this, with nitric acid as recommended by Mr. Fox. In cases where the turpentine "*fake*" referred to is met with, what is the value of the distillation process?

What are the changes due to heating turpentine or rosin oil with strong basic oxides at a temperature sufficiently high for their recovery? and yet Mr. Fox is satisfied with this process for the turpentine determination.—I am, &c.,

Thomas T. P. Bruce Warren.

Tamworth Villa, Earlham Grove,
Forest Gate.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cv., No. 25, December 19, 1887.

The Condition of Sulphur and Phosphorus in Plants, the Earth, and in the Mould, and on their Determination.—MM. Berthelot and André.—In plants sulphur occurs as sulphates; in the form of ethereal compounds, comparable to the ethyl-sulphates and glyceri-

sulphates capable of being split up by hydration under the prolonged action of dilute acids or alkalies or by oxidation; in the form of mineral compounds, such as sulphides, sulphites, hyposulphites, &c., convertible into sulphates in the moist way by the prolonged action of oxidising agents, such as nitric acid; in the form of organic compounds, such as taurine, cystine, the sulpho-conjugated acid and albumen compounds, the sulphur in which is not convertible into sulphuric acid in the moist way. The method which the authors employ for determining the total sulphur of plants, &c., with absolute accuracy, is as follows:— The product, previously dried at 100°, is burnt in a column of oxygen, and the resulting vapours are passed through a long column of pure anhydrous sodium carbonate. The authors operate in a tube of hard glass at a temperature bordering upon redness, but insufficient to enable the sodium carbonate to react upon the glass of the tube. When the organic product is completely burnt the current of oxygen is still kept up for some time, maintaining a temperature bordering upon redness, so as to convert the alkaline sulphuretted salts formed at first into sulphates. When this is done the tube is let cool, the contents are dissolved in sufficient water, acidulated with hydrochloric acid, boiled, and the sulphuric acid precipitatd in the ordinary manner. After the removal of the barium sulphate the phosphorus may be separated as a phospho-molybdic compound, or the phosphoric acid may be determined at once in a special portion. Phosphorus exists in plants in the form of phosphates, soluble in water or in dilute mineral acids; in the form of ethereal compounds; as mineral compounds, phosphides, phosphites, or hypophosphites; or in the form of organic compounds of the order of the oxide of triethyl-phosphine, phenyl-phosphoric compounds, or cerebric acid.

At What Degree of Oxidation are Chrome and Manganese in their Fluorescent Compounds?—Lecoq de Boisbaudran.—As regards chrome no sufficiently definite answer is given; the manganese yielded a little less oxygen than if it had been entirely in the state of MnO_2.

Specific Heat of Tellurium.—Ch. Fabre.—Tellurium possesses approximately the same specific heat in its different conditions, at least for temperatures bordering on 100°. It is possible that the difference is intensified at higher temperatures, and in particular when near the point of transformation of amorphous tellurium into the crystalline form.

Study on an English Coal.—MM. Scheurer-Kestner and Meunier Dollfus.—A thermo-chemical examination of a coal from Glamorgan, known as "Nixon's Navigation."

Optical Isomerisms of Cinchonine.—MM. E. Jungfleisch and E. Léger.—The authors, on dissolving pure crystalline cinchonine sulphate in four times its weight of a mixture of equal parts of water and pure sulphuric acid (sp. gr. 1·84), obtained six new bases, which they name cinchonibine, cinchonifine, cinchonigine, cinchoniline (all isomers of cinchonine), and oxycinchonines α and β.

Attempt at a Diagnosis of the Volatile Alkaloids.—Oechsner de Coninck.—(See p. 2).

Moniteur Scientifique, Quesneville.
Series 4, Vol. i., September, 1887.

Novel Reactions of Sugar.—D. Lindo.—From the Chemical News.

Memoirs on a Purple Silver Chloride, Bromide, and Iodide; on Heliochromy and the Latent Photographic Image.—Carey Lea.— From *American Journal of Science* and Chemical News.

Falsification of Oils.—T. Bruce Warren.—From the Chemical News.

Detection and Determination of Thallium in Platinum.—H. N. Warren.—From the Chemical News.

The Lower Oxides of Molybdenum.—Herr W. Muthmann.—Already noticed under *Liebig's Annalen.*

MISCELLANEOUS.

Cheadle Railway, Mineral, and Land Company.—By an advertisement in our columns it will be seen that this Company invite subscriptions for an issue of 1000 £6 per cent Mortgage Debentures of £100 each, repayable at the end of 25 years, at the price of £110 per bond, they reserving the option to repay the bonds at any time during that period, on giving six months' notice, at the price of £115 per bond. Of the capital of the Company (£250,000, in 25,000 shares of £10 each) £100,000 is already subscribed and allotted. The Company is incorporated for the purpose of constructing a line of railway from the town of Cheadle, in Staffordshire, through Draycott-le-Moors to Cresswell Station, a distance of about four miles, for the purpose of developing the Cheadle and Draycott Coal and Iron Field, and for opening up and developing a valuable building estate at Totmanslow. The Prospectus states that by the construction of the railway the vast mineral wealth of the Cheadle and Draycott Coal Fields can be extracted and transported to London and other markets; and it is proposed to erect Brick, Tile, and Drain Pipe Works, for which the Company's land supplies suitable materials.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened or the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Purification of Refuse Waters.—Can any of your readers tell me the methods successfully adopted for treatment of refuse waters from dye works, tanneries, and wool scouring, or refer me to any work dealing with this subject?—J. S.

Leaden Earrings.—(Reply to B. Jones).—Lead has no pernicious ingredient contained therein to wear in ears, but cannot be worked as fine as gold can; hence, rings of gold are worn instead of copper, iron, or tin in European and American communities, for the former metals are so liable to acquire a deposit of verdigris, which causes blood poisoning. Hence persons who wear earrings prefer gold or silver ones for safety. Several cardinals have worn earrings, and at the Duke of Norfolk's marriage, November 21st, 1877, earrings were worn by several gentlemen who were guests thereat; probably some heraldic custom, his Grace being Earl Marshal. These ornaments were golden wires, and worn by these parties with gravity.—Mary Shoonen.

MEETINGS FOR THE WEEK.

Monday, 23rd.—Medical, 8.30.
Tuesday, 24th.—Institution of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Royal Institution, 3. "Before and After Darwin," by George John Romanes, F.R.S.
Wednesday, 25th.—Geological, 8.
— Society of Arts, 8. "Theatres and Fireproof Construction," by Walter Emden.
Thursday, 26th.—Royal, 4.30.
— Royal Society Club, 6.30.
— Telegraphic Engineers, 8.
— Royal Institution, 3. "My Visits to America," by Hubert Herkomer, M.A., A.R.A.
Friday, 27th.—Quekett Club, 8.
— Society of Arts, 8. "The Public Health in India," by Mr. Justice Cunningham, of the High Court of Judicature, Calcutta.
— Royal Institution, 9. "The Exploration of Masai-Land," by Joseph Thomson, F.R.G.S.
Saturday, 28th.—Royal Institution, 3. "Experimental Optics," by the Right Hon. Lord Rayleigh.
— Physical Society, 3. "The Effect of Magnetisation on the Thermo-electrical Properties of Bismuth," by Herbert Tomlinson. "The Influence of Magnetism and Temperature on the Electrical Resistance of Bismuth and its Alloys with Lead and Tin," E. Van Aubel. "On a Water-dropping Influence Machine; and on the Price of the Factor of Safety in Lightning Rods," Prof. S. P. Thompson.

THE CHEMICAL NEWS.

Vol. LVII No. 1470.

ON SOME AUSTRALIAN INDIGENOUS SALINE FODDER-PLANTS.

By R. W. EMERSON MACIVOR, F.I.C., F.R.G.S., F.C.S., &c.

In some of the inland pastoral areas of Australia, where the soils and waters are more or less saline in character, the ground is covered, not with grass, but for most part with "scrubby" vegetation consisting of several varieties of the *Atriplex* family, and known as "salt-bush" upon which sheep not only thrive wonderfully well, but experience an immunity from diseases of all kinds, unknown in even the richest grass districts. A few years ago Mr. J. Everett, an extensive sheep-owner in Victoria and New South Wales, sent me some specimens of two kinds of salt-bush (*Atriplex speciosus* and *A. campanulata*) growing on one of his newly-acquired properties, with the request that I should report upon their nutritive qualities. The following are my analyses so far as I had time or occasion to carry them:—No. 1 is the average of two analyses and No. 2 of four analyses of thoroughly dry samples.

	No. 1. *A. campanulata.*	No. 2. *A. speciosus.*
Carbohydrates	43·16	42·25
Fibre	12·68	15·48
Albumenoids	14·35	13·70
Fat	2·21	2·20
Ash	27·60	26·61
	100·00	100·26

The ashes (less CO_2) had the following centesimal composition:—

	No. 1.	No. 2.
K_2O.	19·17	22·43
Na_2O	34·75	38·92
MgO	7·05	6·12
CaO.	16·40	13·26
Fe_2O_3	1·55	1·40
P_2O_5	4·62	3·96
SO_3.	3·29	2·44
SiO_2.	2·93	4·14
$Cl(Cl_2-O=55)$	10·25	7·28

The percentage of chloride of sodium in the ash of different samples of each variety varies very much, being sometimes only 2 or 3, and occasionally as high as 38 or even 40.

The most remarkable peculiarity of these plants is that they contain more than twice the average quantity of ash found in any other known plants.

Their high value as fodder for sheep is due to the proportion of carbonaceous and albuminous nutrients they contain, and also to the chlorides and potash which serve to aid digestion and the production of "suint."

NOTE ON MR. ALLEN'S METHOD FOR THE DETECTION OF HOP-SUBSTITUTES IN BEER.

By J. O. ARNOLD.

Some months ago Mr. A H. Allen, President of the Society of Public Analysts, read before that body a Paper (since published in abstract form in the *Journal of the Chemical Society*) in which he announced, with no uncertain voice, that he had discovered a process by which the bitter principles of hop-substitutes—such as quassia, chamomiles, chiretta, &c.—could be with ease and certainty separated from hop-bitters. This process (which is merely a slight modification of a very ancient method) Mr. Allen carries out as follows:—One litre of beer is evaporated to 300 c.c.; the hot liquid is treated with neutral acetate of lead, filtered hot, and if necessary cooled; the excess of lead is thrown down by means of H_2S, and the filtrate is concentrated to 150 c.c. Mr. Allen states that by this treatment "*the hop-resin and lupulin are completely precipitated, while all, or nearly all, hop-substitutes remain in solution.*" The italics are Mr. Allen's.

The concentrated filtrate from the lead sulphide is acidified with sulphuric acid, and is then extracted with chloroform, next with ether, and finally, if necessary, with a mixture of both after liberation of alkaloids with ammonia. Then, according to Mr. Allen, and he again uses italics, "*the presence of some hop-substitute is certain if the chloroform or ether residue has a marked bitter taste.*"

Recently the writer had occasion to test the value of this method, and the results obtained were so suspicious that the matter was further investigated. The following t.ials were carried out with the utmost care.

Experiment 1.—An infusion of 5 grms. of hops was made in 300 c.c. of water. To the hot filtered liquid an excess of normal lead acetate was added, the resulting precipitate was filtered off, and the filtrate allowed to become cold. No further precipitation took place. The excess of lead was removed with H_2S, and the filtrate from the sulphide was evaporated to low bulk, rendered acid with a few drops of dilute H_2SO_4, and was twice extracted with its own volume of chloroform. On evaporating off the latter *an intensely bitter residue was obtained.* The aqueous liquid was next treated with ether, and the residue obtained was also distinctly bitter.

Experiment 2.—Proceeded as in Exp. 1, using, however, basic acetate. The same results were obtained. In this case the liquid required filtering twice, as a further precipitation took place when the fluid became cold.

Experiment 3.—In order to carry out the process under the exact conditions met with commercially, 1 pint of malt was crushed and digested with 2 pints of ordinary water, for two hours, at about 70° C. The wort was strained through muslin, and was boiled with ¼ oz. of hops. The liquid was cooled to 20° C., and a little brewer's yeast was added. After fermenting 18 hours the fluid was filtered, and was found on analysis to contain 2·38 per cent. of alcohol. One litre of this beer (concerning the purity of which there can be no question) was treated exactly in accordance with Mr. Allen's instructions for carrying out his process. *The residue from the chloroform was most bitter, and water shaken with it and dropped on the tongue yielded a bitter taste persistent for about an hour.*

It is quite evident that Mr. Allen's process is misleading, and that the bitter of the hop is *not* completely precipitated by either basic or neutral acetate of lead.

The Laboratory, 34, Bank Street, Sheffield, January 16, 1888.

NEW METHOD FOR THE ANALYSIS OF THE NITRITES.

By A. VIVIE .

On treating an amide, such as urea, with nitrous acid, these two substances are mutually decomposed, with the liberation of nitrogen, water, and the acid corresponding to the amide. This reaction was discovered by Millon, who employed it for the determination of urea in urine. He passed the gases through a weighed Liebig's tube containing caustic potash, and he calculated the weight of

the urea from the weight of the carbonic acid. The author has applied the same reaction to the determination of nitrites, absorbing the carbonic acid, and measuring the nitrogen set free.

It must be remarked that we always collect double the nitrogen contained in the substance to be determined, which is an excellent condition, even if an excess of urea is employed. The process consists in treating the solution containing the nitrite with urea and sulphuric acid, in suitable conditions, passing the gases into an alkaline lye, and determining the volume of the nitrogen. The apparatus consists of a flask holding about 150 c.c., fixed above a Bunsen burner, and closed with a cork having three perforations. One of these admits a tube which introduces a current of pure carbonic acid during the whole time of the operation; the second admits a funnel fitted with a tap for the introduction of the reagents, and the third receives the lower end of a Liebig's condenser, acting *per ascensum*. The other extremity of the condenser communicates with the potash apparatus devised by M. Dupré for the determination of nitrogen in a modification of the Dumas method.

The first step is to expel all air from the apparatus by boiling a little water put in the flask and introducing a current of carbonic acid. The condensed steam returns to the flask in consequence of the arrangement of the condenser.

When the air has been expelled the author introduces successively into the flask, by means of the funnel, the solution containing the nitrite, the requisite quantity of urea dissolved in a little water, and finally, dilute sulphuric acid. The reaction is effected with the aid of heat, and the gases evolved are carried into the potash apparatus by the current of carbonic acid. The liquid is kept at a boil during the entire process. The carbonic acid is entirely absorbed in the potash-ley, and the nitrogen remains pure. The current of carbonic acid is kept up, so that no nitrogen may remain in the apparatus. When this is effected the nitrogen is passed into a jar and measured with the usual precautions. Neither the organic matters of soils nor the nitrates interfere with the reaction.—*Comptes Rendus* (vol. cvi., p. 138).

VALUATION OF INDIGOES.

An Investigation into the Various Methods Employed for the Estimation of Indigotin, together with certain New and Modified Processes.*

By CHRISTOPHER RAWSON, F.C.S.

(Concluded from p. 30).

II. *Sublimation.* — According to Crum, indigo-blue volatilises in open vessels at about 288° in dark purple-red vapours: in closed vessels it decomposes partially when heated. According to Dumas, it volatilises without decomposition only in a current of air or *in vacuo*: the powder dropped on a piece of heated platinum foil volatilises in purple vapours, without leaving a residue, each particle being supported by the vapour, without coming in contact with the foil.

Mr. Charles Tennant Lee (Chemical News, Aug. 1, 1884)† has used a method of sublimation for several years which, in his hands, has yielded most satisfactory results. He employs for this purpose shallow platinum trays, 7 c.m. long, 2 c.m. wide, and 3 to 4 m.m. deep. About 0·25 grm. of finely-powdered indigo, which has been previously dried at 100°, is weighed into the tray and spread in an even layer over its surface. The operation is conducted on an iron plate, which is heated gradually to avoid burning. When the surface of the indigo is covered with a shining mass of crystals, a piece of sheet iron, bent into the form of a low flat arch, is placed over the platinum tray, and, at the same time, as the temperature rapidly rises, the gas is turned down. The vapours of indigotin are now given off, and the heat is gradually raised; but care must be taken lest any yellowish vapours appear, which would indicate the evolution of bodies other than indigotin. When all the crystals of indigotin have disappeared from the surface of the residue, the tray, with its contents, is cooled in a desiccator and weighed. The loss in weight is indigotin. Mr. Lee says that the time required for a 50 per cent indigo is thirty to forty minutes, but soft Java indigo sometimes requires two hours. He also adds that results obtained by this method are constant within 0·25 per cent, but frequently he has made redeterminations, with variations of only half that error.

At first sight, this method appears remarkably simple, combining accuracy with a fair degree of quickness. I have not seen the original paper, but, according to the abstract in the Chemical News, Mr. Lee does not show any figures by which his method can be compared with other recognised processes for estimating indigotin. Indigo contains a variety of substances whose properties have not as yet been thoroughly investigated. I have found that indigo-gluten (including other substances soluble in dilute acid), indigo-brown, and indigo-red are all more or less affected by this process of sublimation, and, furthermore, that pure indigotin (prepared either by Fritzsche's method or by crystallisation from aniline) is partially decomposed, and leaves a dark-brown residue, amounting to upwards of 10 per cent, varying in quantity according to the physical condition of the indigotin operated upon, and also according to the length of time required for the operation. However, it will be seen, on reference to Table II., that in some cases results have been obtained agreeing very closely with those obtained by reduction methods; but, as a rule, inferior qualities of indigo, containing much matter soluble in hydrochloric acid, yield results by this process which are too high; whilst, on the other hand, indigoes rich in indigotin give results which undoubtedly are too low. When performed under the same arched cover, I have frequently obtained, in a given sample of indigo, almost identical results, but when the two analyses have been made under different covers, I have repeatedly found a difference of upwards of 2 per cent in the same sample. It is scarcely necessary for me to add that the estimation of indigotin by sublimation involves a determination of water in the sample.

III. *Methods based upon the Reduction of Indigotin in an Alkaline Solution.*—It would answer no useful purpose in this paper if I were to give a detailed account of all the various methods which have been proposed for estimating indigotin by means of reducing agents. They have all one end in view—namely, the formation of indigo-white, by the action of nascent hydrogen, and its subsequent reoxidation to indigotin. The separation of indigotin from the other matters present in indigo by processes of reduction, although a long and tedious operation, is generally considered to give accurate and reliable results. My experience has been, however, that this is not by any means always the case. Frizsche's method depends upon the reduction of indigotin in an alkaline alcoholic solution by means of grape sugar. The solution is then exposed to the air, when indigotin gradually separates out. Schunk has shown, however, that under certain conditions the whole or part of the indigotin may remain in solution combined with alcohol and acetic acid. Another plan is to treat finely-powdered indigo, out of contact with air, with a solution of ferrous sulphate and slaked lime. After gently heating the mixture for some hours the precipitated matters are allowed to subside; a measured volume of the clear liquid is decanted into a beaker, acidulated, and oxidised to indigotin. The precipitate is collected on a weighed filter, washed, dried, and weighed. The results obtained by this process are generally too low, as some of the indigotin is thrown down in the reducing flask with the mixed precipitate of iron oxides and lime.

* *Journal of the Society of Dyers and Colourists*, No. 4, Vol. I.
† An abstract from the *Journal of the American Chemical Society*.

TABLE II.

Showing the Percentage of Indigotin in Various Classes of Indigoes, by the Employment of Different Methods of Analysis.

Method.	I. Java.			II. Bengal a.			III. Bengal b.			IV. Oude.			V. Kurpah.			VI. Madras.		
	Highest.	Lowest.	Mean.*	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.
1. Permanganate (direct)	76·32	76·05	76·18	66·76	66·68	66·71	62·85	62·32	62·66	50·22	49·86	50·04	47·15	47·15	47·15	39·92	39·30	39·50
2. Permanganate (after precipitation by sodium chloride)	73·82	73·27	73·55	—	—	63·50	57·74	57·30	57·50	—	—	44·90	43·30	42·90	43·10	—	—	37·40
3. Hyposulphite (volumetric)	68·92	68·05	68·78	59·52	58·86	59·26	55·84	55·21	55·66	43·28	43·08	43·18	42·72	42·32	42·52	37·35	36·56	36·80
4. Sublimation	61·03	60·69	60·84	57·95	57·12	57·50	50·50	48·22	49·36	41·96	41·25	41·60	42·37	41·48	41·92	40·42	38·52	39·56
5. Reduction (by ferrous sulphate and sodium hydrate)	68·50	67·82	68·24	59·43	58·12	58·84	56·03	53·59	54·34	—	—	44·50	41·75	40·88	41·50	34·95	33·88	34·50
6. Reduction:—(hyposulphite and lime).																		
Indigotin	69·25	68·65	68·97	59·35	58·89	59·12	56·64	55·92	56·20	43·65	42·99	43·42	42·79	42·15	42·68	35·42	34·98	35·21
Indigo red	4·50	4·01	4·23	3·84	3·24	3·50	3·00	2·60	2·80	3·93	3·42	3·65	2·52	2·25	2·45	4·12	3·75	3·98
Percentage of water ..	—	—	2·99	5·28	5·15	5·22	6·25	6·10	6·17	—	—	7·50	—	—	8·05	5·80	5·62	5·71
" ash	—	—	1·99	—	—	3·91	—	—	4·86	—	—	8·21	25·85	25·62	25·72	33·75	33·50	33·62

* The mean results, in the majority of cases, were deduced from three or more estimations.

Reduction by Ferrous Sulphate and Sodium Hydrate.—This method, devised by Crace-Calvert, gives more reliable results than the preceding ones, but, as described on page 196 of Crace-Calvert's work on "Dyeing and Calico-Printing," it requires a very long time to complete the operation. I have adopted the following plan for carrying out this process. One grm. of finely-powdered indigo is placed in a flask, with 2 grms. of ferrous sulphate, 5 grms. sodium hydrate, and about a litre of water. The flask is closed by a cork with three perforations, in one of which is fixed a syphon for running off the reduced indigo; the other apertures are used for the entrance and exit of a current of hydrogen or coal-gas. The mixture is kept at a temperature a little below the boiling-point for one-and-a-half to two hours, when the source of heat is withdrawn, and the insoluble matters allowed to subside; 500 c.c. are syphoned off, and the rest of the liquid in the flask accurately measured. The reduced indigo is allowed to oxidise, which may be accelerated by drawing a current of air through the solution. If the liquid be now filtered, it would generally take at least a day to pass through the filter, and furthermore, the filtrate would contain in solution a certain quantity of indigotin. On the other hand, if an acid be added to the solution, a variable amount of indigo-brown—dissolved by the caustic soda—would be precipitated with the indigotin and indigo-red. But indigo-brown, as well as indigo-red, is soluble in alcohol, and this property may be advantageously utilised. When the measured volume of reduced indigo has become oxidised, an excess of hydrochloric acid is added, and the precipitate allowed to subside; the clear supernatant liquid is then carefully poured on to a weighed filter, and the residue washed two or three times by decantation with hot water. The residue is now boiled with alcohol, and before filtering the liquid is cooled somewhat, in order that any dissolved indigotin may be deposited. The whole is then transferred to the filter, washed with 80 per cent alcohol, dried at 100°, and weighed. The result is indigotin.

Reduction by Sodium Hyposulphite and Lime.—I have now to describe a method which I believe has not before been published. About three years ago I first attempted to estimate indigotin by means of an alkaline solution of sodium hyposulphite, but only within the last few months have I made the process a success. In point of accuracy it leaves nothidg to be desired, and as regards the time required for its manipulation, it can be performed much more quickly than any other process of reduction. One grm. of finely-powdered indigo is ground into a thin paste with water, and introduced into a flask with 500 to 600 c.c. of lime water. The flask is furnished with an india-rubber stopper, which has four perforations, in one of which is inserted a syphon closed by a pinch-cock, and in another is fixed a funnel provided with a stop-cock; the other two apertures serve for the entrance and exit of a current of coal-gas. The flask is connected with a supply of coal-gas, and the contents heated to about 80° C.; 100 to 150 c.c. of a solution of sodium hyposulphite are now introduced by means of the funnel, and the mixture, which in a few minutes takes a yellow tint, is kept near the boiling-point for half an hour. After allowing the insoluble matters in the flask to subside, 500 c.c. are syphoned off, and the remaining liquid accurately measured. The sodium hyposulphite used in these estimations was five times the strength of the solution which has been previously described.

The 500 c.c. are poured into a conical flask, and by means of an aspirator a current of air is drawn through the liquid for about twenty minutes. The excess of hyposulphite is thus oxidised to sulphite, and the indigo-white to indigo-blue. When hydrochloric acid is added to sodium hyposulphite a copious precipitate of sulphur occurs, but after oxidising the liquid by a current of air the solution remains perfectly clear on the addition of an acid. An excess of hydrochloric acid is therefore added in order to dissolve any carbonate of lime which the pre-

cipitate may contain. The precipitate is collected upon a weighed filter, thoroughly washed with hot water, dried at 100°, and weighed. The weight thus obtained is indigotin and indigo-red. If it is desirable to determine the amount of each of these constituents, the filter with its contents is placed in an extraction apparatus, and the indigo-red dissolved out by means of alcohol. I have found the best form of apparatus for this purpose to be that devised by Prof. Church for the extraction of oil from oil-cakes; it may be found fully described in "Church's Laboratory Guide."

Example IV.—One grm. of indigo was reduced by a mixture of sodium hyposulphite and lime-water. The liquid measured 935 c.c. 500 c.c. were oxidised, and treated as above described. Weight of precipitate = 0·243.

$$\therefore \frac{0{\cdot}243 \times 935 \times 100}{500 \times 1} = 45{\cdot}44 \text{ p. c. indigotin and indigo-red.}$$

The filter was placed in the extraction apparatus, and the red dissolved by means of alcohol. The alcoholic solution was evaporated to dryness, dried at 100°, and weighed. Weight of extract = 0·0145. From this amount 1 m.grm. was subtracted in order to allow for the slight solubility of indigotin in alcohol.

$$\therefore \frac{0{\cdot}0135 \times 100 \times 935}{500} = 2{\cdot}52 \text{ per cent indigo-red.}$$

Indigotin (by difference) = 42·92 per cent.

I have applied the principle of this method to a volumetric process, by means of which, in given samples of indigoes, concordant results have been obtained in less than half an hour. However, as the impurities of indigoes are somewhat affected by the reaction, I deem it advisable to make further experiments before publishing an account of the process.

Recapitulation.—The deductions which I have drawn from these estimations and experiments may be thus summarised:—

1. Indigo, when finely pulverised, is completely dissolved by ordinary concentrated sulphuric acid, at a temperature of 90° to 95° C., in the space of one hour.

2. The permanganate method affords a quick and ready means for the approximate valuation of indigoes, but as substances soluble in dilute acids are, at the same time, more or less acted upon, the results obtained are somewhat too high.

3. If the solution of indigo be saturated with sodium chloride, the colouring-matter is thereby precipitated. When the precipitate is washed, dissolved in dilute sulphuric acid, and titrated with potassium permanganate, results are obtained which, for all practical purposes, are trustworthy and reliable. Indigo-red and indigotin are simultaneously estimated by this modified process.

4. Of all the volumetric methods which have been devised for estimating *indigotin*, the sodium hyposulphite process is capable of giving at the same time the quickest and most accurate results; but, as has been previously stated, considerable care and delicacy are required in its manipulation.

If the solution of indigo to be titrated with hyposulphite contain iron in the ferric state, then the result obtained will be too high.

5. Other bodies than indigotin, which are present in indigoes, are more or less affected by the process of sublimation, whilst indigotin itself is partially decomposed into a dark brown substance, which does not volatilise without complete destruction. According to the quality of the indigo, the results obtained by this process may be either too high or too low.

6. The gravimetric reduction processes, as commonly described, are not quite so accurate as is generally supposed. Perfectly reliable and accurate results are, however, obtained by the use of sodium hyposulphite and lime-water. The reduction is complete in less than half an hour. Where an exact chemical analysis is required, this method, I consider, gives the best results of any process which has hitherto been published.

In conclusion, it gives me pleasure to acknowledge my obligations to Mr. Thornton, who has so cordially afforded me opportunities for carrying on the experiments and analyses connected with the preparation of this paper.

ANALYSES OF GRAPHITE FROM THE BAGOUTAL MOUNTAINS.

By WALTER HEPWORTH-COLLINS.

The four samples of graphite, the analyses of which are appended, are from the Bagoutal Mountains, Siberia.

This graphite is now being used, I am informed, for crucible making, with excellent results.

It seems to be generally of a similar character to that from the Stepanovsky mine (Sergius Kern, Chemical News, vol. xxxii., p. 229).

	Per cent.			
	No. 1.	No. 2.	No. 3.	No. 4.
Carbon..	38·16	38·09	40·31	39·09
Silica	39·22	39·37	38·00	38 75
Alumina.	14·20	13·91	13·21	14·04
Lime and magnesia ..	2·23	3·01	2·07	1·19
Ferric oxide..	4·72	4·10	5·15	4·10
Vol. matt. and loss ..	1·47	1·52	1·26	2·83
	100·00	100·00	100·00	100·00

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IS THERE A CONSTANT RELATION BETWEEN THE HEATS OF FORMATION OF CHLORIDES AND SULPHATES IN AQUEOUS SOLUTION?*

By IRVING W. FAY.

The series of results obtained by Mr. Richards, as above described, suggested the inquiry whether a like constant relation might not be found between the heats of formation of the *chlorides* and *sulphates* in aqueous solution. Accordingly, a series of experiments was made involving this general reaction—

$$\tfrac{1}{n}R_m(SO_4)_n + BaCl_2.2H_2O.$$

All work was done in a constant-temperature room. The calorimeter was the one used by Mr. Richards, and the accessories were in every respect the same as those described by him.

The materials required were a standard solution of barium chloride, and a solution of each of the sulphates to be acted upon containing a sufficient excess to insure complete precipitation of the barium. Accordingly, a standard solution of barium chloride was made of the strength represented by the expression—

$$BaCl_2.2H_2O + 200H_2O.$$

From this standard value the required amount of each sulphate was easily calculated.

For every experiment 250 c.c. of the baric chloride and 250 c.c. of the sulphate solution were used. Hence this amount of water, increased by the water equivalent of the calorimeter, stirrer, and thermometer, gave the total water equivalent, which was exactly the same for each experiment.

The mode of experimenting was precisely like that in the paper by Mr. Theodore W. Richards (Chemical

* *Proceedings of the American Academy of Arts and Sciences.*

News, vol. lviii., p. 16), and the maximum rise of temperature took place in less than fifteen seconds, which rendered unnecessary any correction for cooling. The limit of error did not exceed 0·02° C., and if any accidental cause of uncertainty arose, a second experiment was made for confirmation.

The following example is taken at random from the note-book.

Temperature of $BaCl_2$ sol. in calorimeter ..	16·94°
„ „ Na_2SO_4 sol. in beaker.. ..	16·78°
Mean	16·86°
Final observed temperature	17·50°
Rise of temperature	0·64°

The last column of the following table shows the amount of heat produced by the reaction of one molecule (244 grms.) of baric chloride upon one molecule of sulphuric acid in combination with a base, both being in aqueous solution. The next column to the left gives the observed rise of temperature; and, since the amount of baric chloride used was the same in every case, the values in either column may be directly compared with each other.

		°	C.
1.	$BaCl_2$ and Na_2SO_4	0·64	5171
2.	„ „ Na_2SO_4	0·63	5089
3.	„ „ K_2SO_4.	0·68	5594
4.	„ „ $(NH_4)_2SO_4$.	0·70	5556
5.	„ „ $MgSO_4$	0·70	5556
6.	„ „ $ZnSO_4$.	0·70	5556
7.	„ „ $CdSO_4$.	0·715	5776
8.	„ „ $CuSO_4$.	0·685	5534
9.	„ „ $NiSO_4$.	0·71	5736
10.	„ „ $CoSO_4$.	0·71	5736
11.	„ „ $FeSO_4$.	0·72	5817
12.	„ „ $\frac{1}{3}Al_2(SO_4)_3$	0·805	6504
13.	„ „ $\frac{1}{3}Al_2(SO_4)_3$	0·805	6504
14.	„ „ $\frac{1}{3}Fe_2(SO_4)_3$	0·85	6864
15.	„ „ $\frac{1}{3}Fe_2(SO_4)_3$	0·85	6864
16.	„ „ $\frac{1}{4}K_2Al_2(SO_4)_4$	0·83	6704
17.	„ „ $\frac{1}{4}K_2Al_2(SO_4)_4$	0·81	6544
18.	„ „ $\frac{1}{4}K_2Cr_2(SO_4)_4$	0·80	6464
19.	„ „ $\frac{1}{4}K_2Cr_2(SO_4)_4$	0 79	6184
20.	„ „ $\frac{1}{4}(NH_4)_2Fe_2(SO_4)_4$ ..	1·02	8240
21.	„ „ $\frac{1}{4}(NH_4)_2Fe_2(SO_4)_4$ ..	1·03	8320
22.	„ „ H_2SO_4.	1·225	9904

The first noticeable fact observed in the above table is, that the difference between the heats of formation of chloride and *sulphate* is *not* the same for all metals, as it was found to be in the case of the chlorides and *nitrates*. It will be noticed, however, that with sulphates of allied bases the agreement is as close as before, but the sesquioxide salts give a larger amount of heat than the protoxide, and the double salts a still larger quantity, and sulphuric acid much the largest of all. It is a singular fact, that in the case of common alum the heat evolved is greater than it is with either of its constituent salts.

LEAD SLAGS.

By MALVERN W. ILES.

(Continued from p. 19).

Analytical Data.—In the table of slag analyses, the date indicates when the analysis was performed; in most cases the time of production and the date of analysis do not widely differ. The numbers simply serve to distinguish one kind of slag from another.

The fire assays were in every case carefully determined. The specific gravity determinations were in almost every case found by use of the Jolly spring balance. Some of the earlier determinations of silica are a trifle too high, but by far the largest number of tests were the result of careful fusion. Lately it has been found that accurate silica determinations could be obtained by taking the slag samples in a manner previously mentioned. The iron was determined by the use of a standard solution of potassium permanganate, with, except perhaps, those given by Mr. R. C. Ballard. The lime tests were made partly by gravimetric and partly by volumetric tests. Some of the manganese tests are by the well-known bromine method and weighed either as a phosphate or an oxide of manganese; all of the more recent determinations were made by using the excellent zinc oxide method, the details of which have been fully given under the heading of chemical analysis. The alumina, magnesia, and lead determinations were made by use of the good old fashioned methods. The sulphur test was performed by fusion with caustic potash as above indicated.

In the table of analyses there may be found every kind of type of slag produced in connection with the lead-silver smelting industry I have been able to find up to the time of writing (July, 1884). In several cases certain types have been repeated to show how the lead and silver losses vary under different circumstances, as for example when producing high or low grade bullion. The extreme limits of lead slags may be stated as follows:—

	Per cent.
SiO_2	26 to 41
Fe+Mn	18 to 35
CaO	5 to 35

It is exceedingly rare that the extremes will work satisfactorily for long campaigns; yet often to accomplish certain results, as for example freeing the crucible of the furnace from obstructions or crusts, one can very materially prolong the life or campaign of the furnace by the use of certain extreme slags. By very careful observation based upon analytical data the metallurgist can determine whether the trouble arising from the crucible be due to a siliceous accumulation, an iron crust, or a charcoal, coke, zinc, or lead crust; by acting upon any of these crusts at the right time and for a sufficiently long time with certain slags we can generally eliminate these troubles.

Most of the best slags will have a composition ranging somewhere within these limits:—

	Per cent.
SiO_2	31 to 36
Fe+Mn	23 to 30
CaO	14 to 25

And to still further restrict the limits, we may say that the best work is done, the campaigns are longest, and in the short the most economical slag produced, when its composition lies within these very narrow limits:—

	Per cent.
SiO_2	31 to 34
Fe+Mn	24 to 27
CaO	14 to 25

In some very exceptional cases, and on certain ores, it may be best to have a slag containing less than 31 per cent or more than 34 per cent silica; and the same may be said in regard to the iron, manganese, and lime bases. The prices paid for iron and iron fluxes, taken in connection with the impurities to be contended with, should in short determine the type of slag to be produced. To decide exactly what is the best slag for the treatment of ores where zinc, alumina, magnesia, baryta, and arsenic enter either singly, or all together, in large quantities, is necessarily a very intricate and difficult problem. For the reasons just cited no one slag can be said to be the best under all circumstances. A careful investigation of the analytical data as given in the table will, I think, present some very interesting features, and at the same time disclose some hitherto unrecorded facts.

Analyses of Argentiferous Lead Slags.

Date.	No.	Fire Assay. Ozs. Ag.	Fire Assay. P.c. Pb.	Sp. gr.	SiO_2.	FeO.	Fe_2O_3.	=Fe.	CaO.	MnO.	Al_2O_3.	MgO.	PbO.	ZnO.	PbS.	S.	Total.	Analyst and Remarks.
April 27, 1880	1	2·00	3·00	—	28 10	43·92	4·33	—	5·60	5·58	1·85	3·54	5·23	—	—	0·98	99·13	M. W. Iles.
April 20, 1880	2	2·00	5·75	3·85	26·45	37·11	7·88	—	8·38	5·20	4·29	3·23	6·19	—	—	0·55	99·28	Do.
April 24, 1880	3	3·00	4·50	3·80	28·50	42·21	9·48	—	4·50	5·21	0·62	3·06	6·51	—	—	0·82	100·91	Do.
May 5, 1880	4	2·00	1·50	—	29·15	38 79	6·37	—	6·97	6 97	1·31	4·25	5·88	—	—	0·97	100·66	Do.
June 7, 1880	5	2·50	3·00	—	37·60	41·54	—	—	—	5·02	4·45	—	—	—	—	—	—	Do.
July, 1880	6	2·50	3·15	3·62	31·50	30·40	12·23	—	6·00	4·65	4·40	2·99	5·46	—	—	1·30	98·93	Do.
Jan. 15, 1880	7	1·00	1·25	3·57	30·20	36·19	—	—	22·80	3·81	4·29	0·14	2·36	—	—	0·62	100·41	Do.
	8	—	—	—	29·27	45·17	—	—	8·03	3·91	4·56	4·60	—	—	3·91	—	99·45	R. C. Ballard.
	9	—	—	—	31·32	39·16	—	—	8·52	7·96	5·79	7·79	—	—	2·50	—	103·04	Do.
	10	—	—	—	34·12	37·65	—	—	7·54	4·11	6·23	—	4·45	—	—	—	—	Do.
Oct. 7, 1880	11	Trace	1·00	—	33·50	49·88	—	—	—	—	—	—	—	—	—	—	—	M. W. Iles.
Jan. 17, 1881	12	1·00	1 50	3·56	39·10	39·09	—	(30·40)	8 30	5·02	0·85 (by diff.)	3·80	2·65	—	—	1·19	100·00	Do.
July 12, 1881	13	0·50	0·90	3·45	33·40	34·71	—	(26·99)	25·10	2·00	2·44	Trace	1·57	—	—	0·71	99·93	Samuel James.
	14	—	—	—	31·70	35·62	—	(27·70)	26·50	2·58	2·10	,,	Trace	—	—	0·88	99·38	Do.
	15	—	—	—	31·20	40·35	—	(31·38)	19·90	2·35	2·78	—	3·79	—	—	0·55	100·92	Do.
July 16, 1881	16	1·75	3·50	—	36·40	38·31	—	(29·80)	10·00	—	—	—	—	—	—	—	—	M. W. Iles.
July 27, 1881	17	1·75	2·25	—	35·80	41·65	—	(32·40)	12·40	3·35	2·13	Trace	3·24	—	—	0·86	99·43	Do.
July 30, 1881	18	1·25	2·00	—	40·20	33·43	—	(26·00)	16·60	3·54	2·86	,,	3·12	—	—	0·50	100·25	Do.
July 29, 1881	19	1·46	2·16	—	36·00	41·14	—	(32·00)	13·20	3·54	2·04 (by diff.)	—	3·23	—	—	0·85	100·00	Do.
Feb. 28, 1882	20	—	—	—	37·96	37·14	—	(30·00)	12·84	4·24	4·33	Trace	3·25	—	—	0·90	100·66	Do.
May 7, 1882	21	Trace	1·75	3·50	35·40	38·18	—	29·70	13·50	2·75	—	—	—	—	—	—	—	W. T. Page.
March 29, 1882	22	1·75	2·50	—	34·10	45·00	—	35·00	—	—	—	—	—	—	—	1·52	—	W. R. Boggs.
1879	23	1·79	1·60	3·48	34·79	37·69	—	29·32	13·68	3·87	—	—	—	—	—	—	—	W. R. Boggs. Av. of 15 samples.
	24	1·75	1·25	—	33·00	49·60	—	38·60	10·80	—	—	—	—	—	—	—	—	W. R. Boggs.
	25	5·00	6·50	—	29·00	43·00	—	—	—	—	—	—	—	—	—	—	—	Do.
	26	7·00	8·50	—	34·60	44·20	—	34·40	5·80	—	—	—	—	—	—	—	—	Do.
1880	27	12·00	1·75	3·75	25·80	43·80	—	—	10·10	—	—	—	—	—	—	—	—	Do.
August 30, 1882	28	1·50	3·00	3·65	33·80	47·30	—	—	12·80	1·60	—	—	—	—	—	1·84	—	Do.
Sep. 1, 1882	29	Trace	1·00	—	31 80	33·70	—	—	25·20	1·10	—	Trace	1·60	—	—	1·62	—	Do.
March 21, 1833	30	0·90	1·80	3·60	33·50	37·90	—	—	17·05	—	—	—	—	—	—	—	—	W. T. Page.
	31	3·80	2·10	3·47	33·25	31·90	—	—	19·40	—	—	—	—	—	—	—	—	Do.
1883	32	0·75	1·25	—	35·95	24·40	—	—	25·05	4·75	—	Trace	—	0·30	—	2·67	—	Do.
March 21, 1883	33	5·10	3·10	3·78	32·00	42·70	—	—	14·.0	—	—	—	—	—	—	—	—	Do.
May 23, 1883	34	0·25	1·30	3·75	30·00	43·20	—	—	13·30	4·55	—	—	—	—	—	—	—	Do.
June 14, 1883	35	3·10	10·00	—	28·00	30·94	—	—	16·20	—	—	—	—	—	—	—	—	W. T. Page. Charge incorrectly calc. Mn very large; not determined.
June 20, 1883	36	0·90	2·00	—	35·40	20·36	—	—	14·80	14·83	—	—	—	—	—	—	—	W. T. Page.
	37	1·25	1·25	—	34·00	23·04	—	—	14·80	12·70	—	—	—	—	—	—	—	Do.
Jan., Feb., 1884	38	0·95	1·41	—	36·76	34·45	—	—	16·61	5·38	—	—	—	—	—	—	—	W. T. Page. Av. of 8 analyses; two months' run.
1879	39	3·00	3·00	—	31·00	41·52	—	—	15·00	1·93	—	—	—	—	—	—	—	W. T. Page. Abandoned dump.
	40	3·00	3·70	—	38·40	40·62	—	—	7·00	7·48	—	—	—	—	—	—	—	Do.

(To be continued).

ON MEASURING LIQUIDS BY DROPS.

By A. F. REID.

The size of drops depends upon the form of the surface from which they hang. The following experiments were made with a hundred grain pipette. The number of drops in burettes vary with the position of the stopcock. A pipette was therefore preferred.

1. The number of drops increases with the time taken, thus :—

Water at 2° C., about ½ drop per second	..	141 drops.
,, ,, 2 or 3 drops ,,	..	136 ,,

2. The number of drops increases with the temperature. For example :—

Water at 170° F. (77° C.),	2 or 3 drops per sec.				156 drops.
,, 160° F. (71° C.),	,,	,,	,,		155 ,,
,, 150° F. (65° C.),	,,	,,	,,		154 ,,
,, 140° F. (60° C.),	,,	,,	,,		153 ,,
,, 130° F. (54° C.),	,,	,,	,,		152 ,,
,, 120° F. (49° C.),	,,	,,	,,		151 ,,
,, 110° F. (43° C.),	,,	,,	,,		150 ,,
,, 100° F. (38° C.),	,,	,,	,,		148 ,,
,, 90° F. (32° C.),	,,	,,	,,		147 ,,
,, 80° F. (27° C.),	,,	,,	,,		145 ,,
,, 70° F. (21° C.),	,,	,,	,,		143 ,,
,, 60° F. (15·5° C.),	,,	,,	,,		141 ,,
,, 50° F. (10° C.),	,,	,,	,,		139 ,,
,, 40° F. (4° C.),	,,	,,	,,		137 ,,
,, 32° F. (0° C.),	,,	,,	,,		135 ,,

Near the freezing-point every 10° F. is increased by two drops, at higher temperatures by one drop. The number of drops decreases rather more rapidly near the freezing-point.

3. The number of drops is increased when a substance is in solution :—

Saturated solution of ammonium oxalate at 4° C., 2 or 3 drops per second.. ..	139 drops.
Saturated solution of sodium phosphate at 4° C., 2 or 3 drops per second.. ..	138 drops.

The following are some other liquids at 12° C. at the rate of about two drops per second :—

Absolute alcohol..	387	drops
Ether	452	,,
Carbon disulphide	428	,,
Sulphuric acid	340	,,
Hydrochloric acid	182	,,

This method may be used in determining the relative quantities of alcohol and water in mixtures of these liquids.

Bonshaw, Stewarton, N.B.,
December 30, 1887.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending December 31st, 1887.

By WILLIAM CROOKES, F.R.S.;

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To General A. De Courcy Scott, R.A.,
Water Examiner, Metropolis Water Act, 1871.

London, January 7th, 1888.

Sir,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from December 1st to December 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The whole of the 182 samples examined were clear, bright, and well filtered.

The uniformly excellent character of the water supplied to the Metropolis for a long while past has been satisfactorily maintained during the month of December. In respect to its degree of freedom from tint of colour and excess of organic matter, the numerical results obtained were found to differ but little from those taken note of for some time back. The mean proportion of organic carbon in the Thames-derived supplies, or 0·160 part, and the maximum proportion in any sample, or 0·188 part in 100,000 parts of the water, although indeed slightly in excess of the respective means and maximums of previous months, are quite exceptionally low for the period of the year, as are also the numbers expressing the degree of freedom of the water from colour tint. The mean proportion of organic carbon for the last six months of the year, or 0·143 part in 100,000 parts of the water, corresponds, as nearly as may be, to one-quarter of a grain of organic matter per gallon.

We are, Sir,
Your obedient Servants,
William Crookes.
William Odling.
C. Meymott Tidy.

NOTICES OF BOOKS.

Year-Book of Pharmacy : comprising Abstracts of Papers relating to Pharmacy, Materia Medica, and Chemistry, contributed to British and Foreign Journals from July 1st, 1886, to June 30th, 1887, with the Transactions of the British Pharmaceutical Conference at the Twenty-fourth Annual Meeting, held at Manchester, August, 1887. London: J. and A. Churchill.

This volume contains, as usual, an abundance of interesting matter, much of which, however, has already appeared in various journals. We note with interest the abstract from the *Journal of Physiology* of a paper by Mr. R. N. Wolfenden, in which it is shown that the deadly property of the venom of the cobra is not due to a micro-organism, or ptomaine, or any alkaloid, nor yet to the cobric acid of Blyth, which is pronounced to be merely calcium sulphate. The poisonous ingredients belong to the proteine group, and consist of globuline, syntonine, and serum-albumen.

It is not generally known that the inner bark of the white flowering acacia is decidedly poisonous. At Brooklyn thirty-two boys, who had met with a quantity of the bark, were rendered dangerously ill by chewing it.

The entire section on Materia Medica and Pharmacy is well compiled, and no longer contains any matter which might be preferably classed under Chemistry.

Under Notes and Formulæ we find cantharides, applied to the wound and taken internally, recommended for the prevention of hydrophobia, and cocaine applied to the back part of the throat suggested as a remedy for the disease when it has actually set in.

The dried leaves of the castor-oil plant, in powder, and a decoction of the fresh leaves are recommended for banishing flies and other troublesome insects.

In glancing over the valuable chemical and pharmaceutical bibliography of the year we notice that certain authors, who are Fellows both of the Chemical Society and of the Institute of Chemistry, place after their names the initials F.I.C. *before* F.C.S. Surely the Chemical Society, both in alphabetical order and as the senior society, is entitled to precedence.

The Presidential Address at the Conference, delivered by Mr. S. R. Atkins, contains not a few suggestive passages. Among the conditions required for research, as distinguished from invention and application, he enumerates "an industry bordering on enthusiasm, an indifference to vulgar unreflecting applause, the absence of lionising and public dinners, and the non-necessity of a mill-horse round of teaching others." To such conditions the spirit of the age is, he admits, not helpful to research. Again, "The restlessness of the age is alien to research."

We are glad to find that the Pharmaceutical Conference has begun to award sums of money for assistance in conducting specified lines of research.

The Retrospect of Medicine: being a Half-yearly Journal containing a very Retrospective View of every Discovery and Practical Improvement in the Medical Sciences. Edited by James Braithwaite, M.D. Vol. XCVI., July to December, 1887. London: Simpkin and Marshall.

This volume contains less matter of a character interesting outside of the medical profession than is usually the case.

There is a notice of the newly-discovered poison in milk which has been described, by Dr. V. C. Vaughan, under the name of tyrotoxicon. This poison, doubtless a ptomaine, is chemically speaking diazo-benzol. It is developed in milk by the growth of a micro-organism which multiplies rapidly under favourable conditions. These are principally the exclusion of air, entirely or to a great extent, and a temperature approaching 36°. It is observed that these conditions occur if milk, as it is drawn from the udder of the cow, is placed in cans and tightly closed.

The British Journal Photographic Almanac and Photographer's Daily Companion for 1888. A Complete Compendium of Photographic Art Science. Edited by J. Traill Taylor. London: H. Greenwood and Co.

The multitude of persons who practise photography, whether professionally, for amusement, or as a powerful auxiliary in scientific research, fully warrants the appearance of a special almanac of goodly dimensions. The almanac department, in the strict sense of the word, contains in each month the anniversaries of important steps taken in the art, and, on the opposite page, the meetings of photographic societies.

Then follow, in alphabetical order, notices of the photographic societies of the United Kingdom, the Colonies, America, and the Continent.

Next we find papers on a variety of subjects pertaining to the art. Among these we particularly notice a memoir by Captain Abney, on the "Monochromatic Illumination of Microscopic Objects," and one by Dr. Maddox, on "Small *v.* Large Negatives for Photo-micrographs."

In an essay by Mr. H. P. Robinson, on "Figure, Landscape, and Combination-printing," we regret to find the word "phenomenal" used in its utterly illegitimate sense of "remarkable" or "unusual."

Mr. J. J. Bigginshaw contributes a useful paper entitled "Aids to Photo-microscopy."

After these miscellaneous papers follow "Technical Essays for Young Photographers," in twelve chapters, by the Editor, and an "Epitome of Progress during 1887."

A variety of receipts and formulæ, tables, &c., complete this very useful work.

Report of the Commission of Internal Revenue for the Fiscal Year ending June 30th, 1887. Washington: Government Printing Office.

The contents of this Report scarcely come within our cognizance, being of a kind more calculated to interest economists and statisticians.

Oleomargarine is discussed to some extent, and we learn incidentally that such misleading names as "butterine" are being prohibited in most countries. The analytical methods used in case of suspected samples are those of Hehner and Angell for the estimation of insoluble fatty acids, and that of Reichert for the soluble and volatile fats. It is pointed out that oleomargarine and artificial butters generally are found to be not more, but *less*, liable to rancidity than genuine butter, in consequence of the very small proportion of soluble and volatile butter-acids which they contain. The difference in digestibility between genuine and artificial butters is nearly inappreciable.

CORRESPONDENCE.

A NEW DEPARTURE IN BRAZING AND WELDING.

To the Editor of the Chemical News.

Sir,—The cheapening of oxygen by Brin's process of manufacture has put into the hands of metal workers a new power. I have recently made a few experiments with the compressed oxygen and coal gas, and found that with a ¼-inch gas supply a joint could be brazed in a 2-inch wrought-iron pipe in about one minute, the heat being very short, the redness not extending over 1 inch on each side of the joint.

The appearance of the surface after brazing led me to to experiment further with welding, a process which is not possible with ordinary coal gas and air, owing to the formation of magnetic oxide on the surfaces. Contrary to my expectation a good weld was obtained on an iron wire ⅛ inch in diameter, with a very small blowpipe, having an air jet about $\frac{1}{32}$ inch diameter. This matter requires to be taken up and tried on a large scale for such work as welding boiler-plates, which, it appears to me, can be done perfectly with far less trouble than would be required to braze an ordinary joint. The great advantage of this would be that the boilers would require no handling, but could be welded with an ordinary large blowpipe in position, and with about one-tenth the labour at present necessary.

The cost of the oxygen is trifling, and it is evident, from the results obtained in brazing, that the consumption of gas would be considerably less than one-fourth that necessary with an air-blast, irrespective of the fact that welding is possible with an oxygen-blast, whereas it is not possible if air is used.

The surface of iron heated to welding heat by this means comes out singularly clean and free from scale, and a small bottle of compressed oxygen, with a blowpipe and a moderate gas supply, would make the repairs of machinery, boilers, brewing coppers, and other unwieldy apparatus, a very simple matter. The trouble and difficulty of making good boiler crowns, which so frequently "come down," would be very small indeed when the workmen has an unlimited source of heat at command, under perfect and instant control.—I am, &c.,

Thos. Fletcher.

Warrington, January 17, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cv., No. 26, December 26, 1887.

This issue contains merely a notice of the awards of the prizes the bestowal of which is in the hands of the Academy of Sciences, and the announcement of the prizes proposed for the new year.

Moniteur Scientifique, Quesneville.
Series 4, Vol. i., September, 1887.

Patents taken out in Berlin relating to Colouring-Matters. — These include : — Improvements in the preparation of the mixed azo-colours obtained with benzidine or toluidine and β-naphthylamine-disulphonic acid (A, No. 1646).

Preparation of an α-α-naphthol-monosulphonic acid, of α-α-dioxy-naphthaline and its mono- or disulphonic acids (E, No. 1897).

Preparation of azo-colours by the reaction of the chlorides of tetrazo-diphenyl and tetrazo-ditolyl upon the aromatic meta-diamines and their sulpho-conjugated acids (O, No. 881).

Improvement in the preparation of the colouring-matters patented in Nos. 28,753 and 35,615 (A, No. 1636).

Use of double fluorides of antimony and of the alkaline metals as mordants in dyeing and printing (K, No. 5357).

Preparation of thio-resorcine (E, No. 1921).

Method of preparing alkylic β-naphthylamine-sulphonic acids (F. No. 3059).

Preparation of azo-colours dyeing claret or black-blue shades on wool by means of alkylic naphthylamine-sulphonic acids (F, No. 3113).

Violet tetrazo-colours derived from para-phenylene-diamine (B, No. 7613).

Preparation of alkylic indamines, indo-phenols, new-blue or naphthol-blue (F, No. 3118).

Vol. i., Part 2, October, 1887.

The Production of Chlorine in the Preparation of Oxygen from Potassium Chlorate.—F. Bellamy.—The author examines the manner of action of manganese dioxide, copper oxide, &c., in facilitating the liberation of oxygen from potassium chlorate by heat. He considers that these substances act by alternate super-oxidation and reduction, and that they act like acids. During these reactions compounds of chlorine are formed even if no impurities are present. When working with ordinary chlorate alone chlorine was found among the gaseous products in thirteen cases out of fourteen. The quantities are very variable. When manganese is used along with the chlorate large quantities evolve more chlorine than small ones. The author concludes that whatever substance is used to facilitate the decomposition of the chlorate, chlorine gas is evolved, especially at the beginning of the operation.

New or Improved Methods for Determining Organic Bodies by Means of Oxidation with Potassium Permanganate.—J. H. Smith.—From the *Journal of the Society of Chemical Industry.*

Notes on a Recent Visit to the Oil Regions of the United States and Canada. — Boverton Redwood. —From the *Journal of the Society of Chemical Industry.*

Contribution to the Study of Rotatory Polarisation in Parallel Light.—Dr. G. Quesneville.—This memoir does not admit of useful abstraction.

Researches on Gold.—Gerhard Krüss.—From *Liebig's Annalen.* The most important portions of this memoir have already appeared in the CHEMICAL NEWS.

The Alkaloids of the Coca Leaf.—O. Hesse.—From the *Pharmaceutical Journal..*

Industrial Review and Various Patents.—Abstracts of specifications, chiefly German.

Patents on Colouring-Matters taken out at Berlin. —These include :—Improvement in the preparation of β-naphthylamine-δ-monosulphonic acid. F. Bayer and Co., of Eberfeld. F, No. 3055.

Preparation of ethers of meta-diamido-diphenic acid. Dr. L. Paul. P, No. 3099.

Preparation of benzyl acetate and ethylene diacetate. E. Seligin. S, No. 3620.

Soluble combinations of naphthazarine and of sulphites; dyeing blacks or greys with this compound, or with naphthazarine. Baden Aniline and Soda Works. B, 4579.

Preparation of oxypyrazol by the action of the amides of acetyl-acetic ether, simple or substituted, upon phenyl-hydrazine. Meister, Lucius, and Bruning. F, No. 3140.

Improvements in the preparation of azo-colours obtained by the reaction of the chlorides of tetrazo-diphenyl or tetrazo-ditolyl upon the aromatic meta-diamines. K. Oehler. O, No. 904.

A colour for dyeing textile fibres. T. Maxwell and J Young. M, 4961.

Preparation of tetra-hydro-para-oxyquinoleine and its conversion into thalline. Baden Aniline and Soda Works. B, No. 7470.

Conversion of certain colouring-matters obtained according to Patent 38,735 into colours not sensitive to the action of alkalies. A. Leonhardt. L, No. 4003.

Preparation of a dioxy-naphthaline monosulphonic acid. Berlin Joint Stock Aniline Co. A, No. 1501.

Yellow, brown, or red-brown azo-colours obtained with the dioxy-naphthaline-monosulphonic acid of the foregoing Patent. Berlin Joint Stock Aniline Co. A. 417.

Improved preparation of β-naphthylamine-δ-monosulphonic acid. Fr. Bayer and Co. F, No. 3077.

Further improvement in the preparation of β-naphthylamine-δ-monosulphonic acid. F. Bayer. F, No. 3104.

Colouring-matters prepared with tetrazo-dibenzol-diphenyl or its homologues, and resorcine, orcine, and naphthionic acid. E. Kegel. K, No. 5410.

Blue colouring-matters prepared with tetrazo-diphenol-ether. F. Bayer. F, No. 3216.

Purification of crude anthracene. C, No. 2258.

Preparation of dialkylic amido-benzophenones. Meister, Lucius, and Bruning. F, No. 3186.

M. Chevreul entering into his 102nd Year.—The congratulatory address of the Royal Academy of Sciences of Prussia.

Inauguration of the Statue of Nicolas Leblanc.—A discourse delivered by M. E. Peligot.

Experimental Solicitation of Emotive Phenomena in Subjects in a Hypnotised State.—J. Luys.—This memoir has no relation to chemistry.

Contribution to a Knowledge of Antimony Perchloride.—R. Anschütz and N. Evans.—A paper read before the Royal Society.

On Metallic Manganese.—Th. Bruce Warren.—From the CHEMICAL NEWS.

MISCELLANEOUS.

Explosives Act, 1875.—Colonel Majendie has forwarded to us the following copy of circular letter which he has addressed to the principal manufacturers and users of picric acid in the United Kingdom :—

"HOME OFFICE, 18th January, 1888.

"I have the honour to forward, for your information and guidance, two copies of an Order in Council which was made on the 29th December, 1887, and has since been duly published in the *London Gazette.*

"The effect of this Order is substantially as follows:—

"Whereas picric acid, picrates, and mixtures or combinations of picric acid with certain other substances, have hitherto ranked as "explosive" (within the meaning of the Explosives Act, 1875) *only* when "manufactured or used with a view to producing a practical effect by explosion or a pyrotechnic effect," in future—

"(1) Picric acid when in *process of manufacture or storage* (for whatever purpose used or manufactured) will rank as an explosive except when certain conditions, (*a*) and (*b*), as set forth in the Order are complied with; and—

"(2) Picrates and mixtures of picric acid with substances capable of forming an explosive mixture or an explosive compound (for whatever purpose used or manufactured) will rank as explosives for all the purposes of the Act (and not merely when in process of manufacture or stowage), except when wholly in solution.

"Accordingly, if you are unable to satisfy the exempting conditions set forth under (1) and (2) above, you should take steps to ascertain the requirement of the Act affecting nitro-compounds, and to conform to the same as far as they may be applicable to your business."

The following are the conditions (*a*) and (*b*) referred to in the above letter:—

(*a*) Picric acid when wholly in solution shall be exempt from being deemed to be an explosive within the said Act; and—

(*b*) Picric acid which does not fall within the exemption (*a*) above set forth, but which is being manufactured or stored in a factory, building, or place exclusively appropriated to the manufacture or storage of picric acid, and in such manner as effectually to prevent any picric acid from coming into contact (whether under the action of fire, or otherwise) with any basic metallic oxide or oxidising agent, or other substance capable of forming with picric acid an explosive mixture or explosive compound, or with any detonator or other article capable of exploding picric acid, or with any fire or light capable of igniting picric acid, shall be exempt from being deemed to be an explosive within the said Act.

NOTES AND QUERIES.

Magnetic Carbide of Iron.—Can any reader supply information respecting the process of manufacturing magnetic carbide of iron, used, I believe, sometimes for filtration?—Junior.

MEETINGS FOR THE WEEK.

Monday 30th.—Medical, 8.30.
— Society of Arts, 8. "Yeast, its Morphology and Culture," by A. Gordon Salamon, F.C.S.
Tuesday, 31st.—Institution of Civil Engineers, 8.
— Society of Arts, 8. "Monumental Use of Bronze," by J. Starkie Gardner, F.G.S.
— Royal Institution, 3. "Before and After Darwin," by George John Romanes, F.R.S.
Wednesday, Feb. 1st.—Society of Arts, 8. "The Sweating System, or the Functions of the Middleman in relation to Labour," by D. F. Schloss.
Thursday, 2nd.—Royal, 4.30.
— Royal Institution 3. "Art Education," by Hubert Herkomer, M.A., A.R.A.
— Chemical, 8. Ballot for the Election of Fellows. Lecture on "The Range of Molecular Forces," by Prof. A. W. Rücker, F.R.S.
— Parkes Museum, 5. "The History and Present Position of the Germ Theory of Disease," by Prof. E. M. Crookshank, M.B.
Friday, 3rd.—Geologists' Association, 8. (Anniversary).
— Royal Institution, 9. "Ancient Microscopes," by Frank Crisp, LL.B., &c.
Saturday, 4th.—Royal Institution, 3. "Experimental Optics," by the Right Hon. Lord Rayleigh.

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THE CHEMICAL NEWS.

Vol. LVII. No. 1471.

THE ACTION OF SULPHUR AND SULPHUR CHLORIDE ON OILS.

By THOMAS T. P. BRUCE WARREN.

The adulteration of lard and lard oil with cotton-seed oil, &c., can easily be detected by sulphur chloride. The separation of certain vegetable oils from animal oils and fats has been suggested by Parkes's Patent and disclaimer referred to in Chemical News (vol. lvii., p. 26).

As regards adulterated lard it is satisfactory to find that the Americans have made up their minds to deal boldly with this fraud. As we followed the Americans in framing the Margarine Act, we shall probably have some new legislation dealing with adulterated lard: that this fraud should be tolerated in the face of the "Food and Drugs Act, 1875," passes my comprehension.

American lard has been largely imported into this country, and a very great deal has been actually manufactured in this country in the same way. The injurious effect which this bogus lard has had upon our agricultural industry is too obvious to need comment. The injury to the lard-oil trade will be complete when users of this oil for lubricating know that the adulterated article can be put together for about one-half the price now paid for lard oil.

It cannot be urged that these frauds have just been exposed. If those interested in this subject will refer to the Chemical News (vol. lv., p. 134) they will find the statement that a firm in Chicago used one-fifth of the entire produce of cotton-seed oil in packing their lard, and that American lard is largely adulterated with cotton-seed oil. In vol. lvi., p. 133, we note that "sesame oil would be a good substitute for lard or butter."

Cotton-seed oil is used in vegetarian cookery; it is perfectly wholesome, and no one wishes to say anything against it on this point. But when it is used as a means for passing off the harder fats of beef or mutton as lard made from the fat of the pig, we are quite justified in regarding the matter with indignation.

The *Standard* (January 25th) gives some startling figures on this subject. About 50 million pounds of cotton oil are annually used in America in lard factories.

Sulphur chloride reveals this fraud without any difficulty. The melting-point of the fat, after removal of the oil, will enable one to say whether the pig has been requisitioned for fat in compounding this lard. The melting-point of the mixture is of no value as a test in this case.

It is not very flattering to our chemical reputation to wait until a foreign power finds the extent of a fraud becoming so formidable that it is necessary to deal with it so harshly as the Bill proposed by Senator Dawes proposes. In 1886-7 more than 100 million pounds of lard were produced over that of any previous year.

Adulteration is now carried out with *quasi*-scientific perfection; it is a mistake to rest upon a method of detection which is generally known, because anyone with a qualmish notion of honesty will not rest until he can circumvent the method. We do not find many cases of "bungling" fraud: on this account we must be prepared to deal not only with recognised systems of adulteration, but with any possible admixture which may be feasible.

The Antwerp Board of Trade have recently forwarded some strong representations to New York respecting this fraud, which will probably result in excluding from Belgium the import of this lard.

LEAD SLAGS.

By MALVERN W. ILES.

(Continued from p. 38).

Types.—By the term "slag types" are meant those slags which are built up according to some well-defined composition, and which always have a distinct crystalline form. Many of these types approach in composition certain well-known siliceous minerals. It is somewhat rare to find in the same piece or pot of slag more than a single kind or type, though such cases will occur occasionally when there is a marked change in the ore charge, or where there is fed into the furnace a slag different in composition from that produced by the ore and lime flux. I have studied slags, with no small amount of care and attention, through the following wide ranges of composition:—

	Per cent.
SiO_2	26 to 41
Fe	18 to 45
CaO	5 to 35
Mn	Trace to 40
MgO	Trace to 8

While it is possible, and even probable, that there may be some particular kind or class of slags which has escaped observation, the following types will include practically every known slag which is well adapted for argentiferous lead smelting:—

Types of Lead Slags.

Type.	Percentage.		
	CaO.	FeO+MnO.	SiO_2.
A	6	52	32
B	10	45	35
C	12	50	28
D	16	34	34
E	20	40	30
F	24	33	33
G	28	27	35

It must not be understood that these types are rigidly fixed, since all of them are subject to certain ranges or limits, and still may be quite fair slags. Some, it has been noticed, are subject to wider limits than others; this is particularly true of the type F. By observation and long experience it has been found that slags of a certain kind are easily fusible, run freely, prevent certain mechanical difficulties in the crucible, and admit of long campaigns. These slags occasion small silver and lead losses, and are therefore to be imitated as nearly as practicable; but to say that a certain slag is good or bad if the type is not accurately obtained is certainly erroneous. Where the type is so clearly approached that there occur certain slight alterations in the crystalline form, the slag may be, and generally is, a very good one to make; now to alter the slag so that the type may be more closely approached will sometimes be highly impolitic from a commercial standpoint. If, in short, we alter a slag which already closely approaches a given type, the cost should be an important item in the consideration, and not the beauty of the crystals.

I have noticed that most slags produced *between* certain recognised types assume a distinct appearance which more or less resembles that of the minerals pectolite and wavellite. Slags having a structure closely resembling these minerals may be designated as pectolitic or wavellitic slags. From what has been said it will be seen that all pectolitic and wavellitic slags may be regarded as abnormal. Generally pectolitic and wavellitic slags run high,—that is to say, carry too much lead and silver, especially the latter,—yet a very few exceptions to this statement have been noted where manganese enters largely into the composition.

There are a few well-defined crystalline slags which

ANALYSES OF ARGENTIFEROUS LEAD SLAGS (*continued*).

Date.	No.	Fire Assay. Ozs. Ag.	Fire Assay. P.c. Pb.	Sp. gr.	SiO_2.	FeO.	Fe_2O_3.	=Fe.	CaO.	MnO.	Al_2O_3.	MgO.	PbO.	ZnO.	PbS.	S.	Total.	Analyst and Remarks.
Feb. 24, 1884	41	1·00	1·50	—	32·50	36·90	—	—	19·00	3·87	—	—	—	—	—	—	—	W. T. Page.
Dec. 27, 1882	42	1·00	1·75	—	37·40	35·22	—	—	14·90	—	—	—	—	—	—	—	—	Do.
Feb. 1, 1883	43	Trace	1·50	—	38·40	33·90	—	—	13·20	—	—	—	—	—	—	—	—	Do.
March 14, 1883	44	1·25	1·25	—	31·50	28·00	—	—	18·90	—	—	—	—	—	—	—	—	Do.
May 2, 1883	45	1·00	0·50	—	31·50	27·50	—	—	20·10	—	—	—	—	—	—	—	—	Do.
May 3, 1883	46	0·50	0·50	—	32·75	26·50	—	—	20·30	—	—	—	—	—	—	—	—	Do.
Jan. 18, 1883	47	Trace	0·40	—	35·00	36·00	—	—	14·00	—	—	—	—	—	—	—	—	Do.
Feb. 23, 1884	48	1·25	0·50	—	31·75	31·37	—	—	16·40	—	—	—	—	4·53	—	—	—	Do.
	49	0·50	1·00	—	33·00	14·22	—	—	13·10	25·78	4·20	1·00	—	—	—	—	91·30	Do.
	50	Trace	1·40	—	29·60	11·56	—	—	7·50	43·25	6·34	Trace	—	—	—	—	98·25	Do.
Feb. 23, 1884	51	0·80	0·50	—	35·75	31·24	—	—	16·20	—	—	—	—	—	—	—	—	Do.
March 5, 1884	52	1·60	0·80	—	36·25	31·10	—	—	17·90	3·61	—	—	—	—	—	—	—	Do.
Oct. 2, 1882	53	0·05	0·90	—	33·50	31·90	—	—	17·90	—	—	—	—	—	—	—	—	Do.
March 13, 1884	54	Trace	0·70	—	33·80	34·20	—	—	19·25	3·47	—	—	—	—	—	—	—	Do.
March 17, 1884	55	1·20	0·70	—	33·80	30·20	—	—	20·75	4·14	—	—	—	—	—	—	—	Do.
March 19, 1884	56	1·90	0·70	—	34·00	29·96	—	—	20·80	3·99	—	—	—	—	—	—	—	Do.
March 21, 1884	57	1·50	0·70	—	34·40	29·83	—	—	19·80	3·89	—	—	—	—	—	—	—	Do.
March 24, 1884	58	1·20	0·50	—	34·25	32·80	—	—	17·10	3·45	—	—	—	—	—	—	—	Do.
April 3, 1884	59	1·70	1·10	—	33·85	29·90	—	—	19·90	3·51	—	—	—	—	—	—	—	Do.
April 7, 1884	60	1·30	0·50	—	33·20	30·34	—	—	20·60	3·50	—	—	—	—	—	—	—	Do.
April 9, 1884	61	0·80	0·70	—	33·10	30·09	—	—	19·80	4·75	—	—	—	—	—	—	—	Do.
April 11, 1884	62	1·10	0·50	—	31·85	32·98	—	—	20·05	4·54	—	—	—	—	—	—	—	Do.
April 14, 1884	63	1·05	0·40	—	31·95	30·90	—	—	22·75	3·22	—	—	—	—	—	—	—	W. T. Page. 135-oz. bullion.
April 15, 1884	64	0·45	0·50	—	33·00	28·93	—	—	23·65	3·42	—	—	—	—	—	—	—	W. T. Page. 138 oz. bullion.
April 18, 1884	65	0·50	0·70	—	32·90	29·11	—	—	22·00	2·86	—	—	—	—	—	—	—	W. T. Page. 160-oz. bullion.
April 22, 1884	66	0·60	0·50	—	33·00	26·89	—	—	23·95	3·00	—	—	—	—	—	—	—	W. T. Page.
April 28, 1884	67	1·40	0·60	—	33·20	27·51	—	—	24·00	—	—	—	—	—	—	—	—	Do.
March 5, 1884	68	0·50	0·60	—	34·60	30·09	—	—	22·00	2·97	—	—	—	—	—	—	—	Do.
	69	—	—	—	36·00	32·00	—	—	25·60	—	—	—	—	—	—	—	—	H. T. V. Furman. Pectolitic, fibrous.
	70	—	—	—	32·00	36·47	—	—	24·23	—	—	—	—	—	—	—	—	H. T. V. Furman. Fine translucent crystals.
	71	—	—	—	27·60	45·00	—	—	20·64	—	—	—	—	—	—	—	—	H. T. V. Furman. No lead found.
	72	—	—	—	29·80	39·50	—	—	19·30	—	—	—	—	—	—	—	—	H. T. V. Furman. "Old German slag."
	73	—	—	—	31·00	34·83	—	—	24·10	—	—	—	—	—	—	—	—	H. T. V. Furman. Tetragonal crystals.
	74	—	—	—	32·20	28·50	—	—	27·50	—	—	—	—	—	—	—	—	H. T. V. Furman. Almost cubes.
	75	—	—	—	25·50	40·97	—	—	16·00	—	—	—	2·70	7·62	—	—	—	H. T. V. Furman. Aluminous.
	76	—	—	—	35·80	25·50	—	—	29·50	0·60	3·90	—	1·36	—	—	—	—	H. T. V. Furman. Ran free.
	77	—	—	—	37·60	20·07	—	—	29·23	0·41	5·50	—	4·68	—	—	—	—	H. T. V. Furman.
	78	—	—	—	36·20	26·20	—	—	30·00	—	—	—	—	—	—	—	—	Do.
	79	—	—	—	32·20	27·70	—	—	25·20	—	—	—	—	6·05	—	—	—	Do.
	80	—	—	—	35·80	23·74	—	—	28·20	—	6·65	—	—	—	—	—	—	Do.
	81	—	—	—	39·00	22·30	—	—	29·84	—	—	—	—	—	—	—	—	Do. Very bad. Furnace closed.

February, 1884	82	0·35	*0·88	—	36·20	24·17	—	—	18·75	9·41	3·95	0	0·88	4·67	—	0·83	98·86	W. T. Page. Resembles porcelain.			
February 1, 1884	83	1·50	0·30	—	34·00	33·43	—	—	16·60	—	—	—	—	—	—	—	—	W. T. Page. 185-oz. bullion.			
January, 1884	84	0·20	0·25	—	32·50	29·06	—	—	28·50	0·23	2·71	0	—	3·60	—	1·15	97·75	W. T. Page. 70-oz. bullion. Monoclinic crystals.			
February, 1884	85	1·00	1·10	—	37·70	35·48	—	—	14·00	7·48	—	—	—	—	—	—	—	Old Leadville slag.			
	86	1·50	1·20	—	35·30	35·35	—	—	18·00	3·87	—	—	—	—	—	—	—				
	87	0·60	1·80	—	37·00	36·38	—	—	13·50	8·39	—	—	—	—	—	—	—				
	88	0·90	1·30	—	38·20	32·52	—	—	17·70	5·80	—	—	—	—	—	—	—				
April, 1884	89	1·40	1·60	—	36·50	38·57	—	—	15·00	7·20	—	—	—	—	—	—	—				
	90	3·00	2·80	—	37·50	41·65	—	—	5·30	10·30	—	—	—	—	—	—	—				
	91	0·60	1·00	—	31·50	41·52	—	—	16·50	6·07	—	—	—	—	—	—	—				
	92	0·60	0·90	—	33·80	36·22	—	—	15·90	8·52	—	—	—	—	—	—	—				
	93	0·80	0·60	—	35·70	38·95	—	—	15·40	5·54	—	—	—	—	—	—	—				
	94	0·50	1·00	—	32·60	36·80	—	—	16·60	4·00	—	—	—	—	—	—	—				
	95	1·25	1·50	—	34·60	41·80	—	—	15·10	4·00	—	—	—	—	—	—	—				
	96	1·25	1·50	—	34·90	35·70	—	—	15·00	—	—	—	—	—	—	—	—	Three hours after "blowing in."			
	97	5·00	3·00	—	40·00	17·70	—	—	22·30	—	—	—	—	—	—	—	—				
	98	1·20	2·10	—	38·00	27·60	—	—	11·30	—	—	—	—	—	—	—	—	Type for impure ores—*A*.			
	99	—	—	—	33·00	40·00	—	—	16·00	—	—	—	—	—	—	—	—				
	100	—	—	—	33·00	33·00	—	—	23·00	—	—	—	—	—	—	—	—	Type for impure ores—*B*.			

* By wet analysis.

are not adapted to lead smelting; this is particularly the case where the percentage of iron is very high and that of lime is low (see type A, Fig. *a*, and analyses Nos. 1, 2, 3, 4, and 6).

(To be continued.)

THE ESTIMATION OF IODINE.

By NORMAN McCULLOCH.

IN a Paper contributed by me to the CHEMICAL NEWS (vol. lvii., p. 27), embodying the results of a few experiments on the volumetric estimation of cobalt in presence of nickel, there is a brief consideration of the reaction between nickel peroxide and iodine or its hydracid salts, involving reduction of the former to the protoxide, and oxidation of the latter to iodic acid or an iodate; and as nickel peroxide is entirely without oxidising influence on the salts of hydrochloric and hydrobromic acids, the application of these facts to the determination of iodine in presence of chlorine and bromine naturally suggested itself: the neutral or alkaline solution of the chloride, bromide, or iodide was to be treated with excess of the "peroxide," and the iodic acid in the filtered solution to admit of gravimetric or oxidimetric estimation. Not that I assumed the principle of the proposed method to be new. The process suggested by Pean de St. Gilles, and developed by Reinige (*Zeitschr. f. Anal. Chem.*, 939), involves the oxidation of the iodine as iodide in alkaline solution with a standard solution of potassium permanganate, and the complete conversion to iodate, known by the pink colour of the titrated liquid as seen on subsidence of the precipitated manganic hydroxide. Concerning this process I would point out, I think, an overlooked fact. It is generally assumed that the composition of manganic hydroxide, precipitated in virtue of the reaction between permanganate of potash and potassium iodide, is represented by the formula MnO_2, and the following is the usual equation, in which it is shown as such:—

$$KI + K_2Mn_2O_8 = KIO_3 + K_2O + 2MnO_2.$$

But this equation I am satisfied is not strictly representative of the truth, and due to the fact that manganic dioxide in presence of salts of hydriodic acid undergoes a slight but distinct reduction. This I consider proved, in a measure, by the experiments of Table I. The titre figures of four manganese determinations by the Pattinson process are there shown, but the precipitates of Experiments III. and IV. have been warmed with a weak solution of potassium iodide (10 grs. KI + 3 ozs. H_2O) previous to their solution and titration with the iron and bichrome solutions.

TABLE I.

No. of Exp.	$MnSO_4$ cryst. taken.	Iron solution used.	Bichrome sols.
I.	5 grs.	50 divs. (500 grs.)	8·4 divs.
II.	,,	,,	8·2 ,,
III.	,,	,,	8·8 ,,
IV.	,,	,,	8·8 ,,

The difference between the composition of the treated and non-treated precipitate is certainly not startlingly significant, but that difference I assert to be greater than I have yet found between duplicate experiments with the Pattinson process, finding them generally identical, and with a maximum difference of a fifth of a div. (10 grs.) only. But we obtain a striking confirmation of the partial reduction of the manganese dioxide on acidifying the potassium iodide solution used in its treatment, when the distinct liberation of iodine apparent can only be attributable to the presence of iodic acid formed by the oxidising action of the manganese dioxide. But the quantitative results of Table I. are by no means, I consider, altogether indicative of the actual extent of the reduction. Subsequent experiments satisfied me that at

least traces of the iodic acid would enter into union with the manganese precipitates to the formation of compounds stable not only in water, but in boiling sulphuric acid, and forming a source of error to be considered in interpreting the results of the above Table.

It may be reasoned, then, from these facts, that the manganese hydroxide precipitated on addition of permanganate to a potassium iodide solution, is not the *dioxide*, but a compound of lower oxygen content. Consequently two molecules of permanganate are equal to the oxidation of rather more than one molecule of iodine, and, as I suspect that the equivalent will vary slightly with circumstances of temperature, dilution, &c., I do not, summarily speaking, consider the basis of the Gilles-Reinige process a satisfactory one for the exact volumetric estimation of iodine. There were, I need scarcely say, difficulties in the way of applying potassium permanganate to the oxidation of alkaline iodide solutions (in presence of chloride or bromide) with a view to the subsequent estimation of the iodine as iodic acid. By-and-bye, it is true, these difficulties were evaded, but I describe my experiments in the order of their priority.

There was, firstly, the practical impossibility of removing by filtration the finely divided manganese hydroxide; and secondly, and it has already been mentioned, the tendency of that oxide to combine with the iodic acid.

This latter—and the more objectional—feature I found, with the progress of my experiments, to be also exhibited by nickel peroxide, and to such an extent that in one experiment, applying it to the oxidation of 3 grains of potassium iodide dissolved in water distinctly alkalinised with caustic soda, fully one-third of the iodic acid combined with the nickel oxide, to the formation of, I think, a basic compound, and necessitating solution of the filtered and washed oxide in dilute sulphuric acid, in order to recover the iodic acid for estimation with the main portion in the filtrate. But I finally decided to abandon this process. I failed in devising a convenient and exact method for separating iodic from hydrochloric and hydrobromic acids, and the alternative lay in decomposing it with potassium iodide and applying the starch and hyposulphite method to the titration of the liberated iodine. There was not that superior simplicity and convenience in the method to recommend it for the substitution of those already in use.

Further experimental work was now a consideration of certain reactions of hydrogen peroxide as a possible basis for determining iodine in presence of chlorine and bromine.

Aqueous solutions of free chlorine and bromine, if sufficiently weak, reduce completely to hydrochloric and hydrobromic acids respectively in presence of hydrogen peroxide. This reducing action of hydrogen peroxide is facilitated by presence of bases capable of combining with the acids as formed. We observe, on the other hand, on treating strong hydrochloric or hydrobromic acid with peroxide of hydrogen (20 vols.), a slight evolution of chlorine or bromine, as the case may be. With the former acid this decomposition is not very appreciable, but sufficiently so with the latter. Concentrated solutions of acid metallic salts of hydrochloric and hydrobromic acids—for instance, the iron and aluminium compounds—show a similar tendency to evolve chlorine and bromine, but to a much less extent.

On now noting the behaviour of iodine with hydrogen peroxide, we observe a distinct dissimilarity of reaction from the other two halogens. In warm aqueous solution it incurs easy and immediate oxidation, the oxidised product being iodic acid. In presence of a base, on the other hand, we have it behaving analogously with chlorine and bromine in suffering reduction to hydriodic acid. The quantity of base necessary to insure the completeness of this reduction varies with the nature of the base employed. Potassa and soda, for instance, need be used only in slight excess of the chemical equivalent to form the odide, but with the weaker bases—say ferric oxide and alumina—we must employ a quantity greatly exceeding this proportion.

When metallic iodides are warmed in solution with hydrogen peroxide, they incur partial decomposition to free iodine and their respective oxides. But, however great the excess of hydrogen peroxide present, the liberated iodine exhibits no tendency to oxidation. An equilibrium seems established in the liquid, in which the tendency to oxidise is balanced by its tendency to reduce in presence of the liberated oxide or base.

I failed in directly turning the above facts to practical account. The object desired was the conversion of the iodine to iodic acid, but in presence of chlorine or bromine this was not to be effected completely by hydrogen peroxide. The reason of this was not far to seek. We had but to consider the well-known reaction between iodic and hydrochloric and hydrobromic acids, by which the former is reduced to iodine, and chlorine and bromine evolved from the two latter, and with this fact to combine that of the reducing influence of hydrogen peroxide on the chlorine and bromine in their conversion to hydrochloric and hydrobromic acids, and so reformed for further reducing action on the oxidised iodine. But the experiments were not altogether unfruitful in directly suggesting the way to a complete solution of the problem under investigation. It occurred to me that the above difficulty in the decomposing action of the acids, hydrochloric and hydrobromic, on the oxidised iodine, might be avoided by the use of an oxidant capable of liberating the chlorine and bromine of the reducing acids, as well as effecting the oxidation of the iodine, and by the application of heat to separate the volatile halogens from the non-volatile iodic acid. I returned to a consideration of potassium permanganate to be applied as the oxidant in the manner indicated, and the details of the procedure were as follows:—

Dry re-sublimed iodine was dissolved in a little pure caustic soda solution contained in a No. 7 Berlin porcelain basin, and after the addition of the chloride, bromide, or other substance employed (See Table II.) was treated with dry potassium permanganate, and in proportion as follows:—Of the eight molecules of oxygen contained in two molecules of potassium permanganate, three only were considered as available for the purpose required, and by simple calculation we find that the liberation of chlorine, bromine, and, as well as oxidation of, iodine from their hydracids demand a proportion of 1·48, 0·65, and 2·48 parts potassium permanganate respectively. But in practice these proportions are advisably exceeded, and may be greatly so without endangering the accuracy of the method. With the addition of the permanganate the contents of the basin are warmed, to facilitate its solution as well as its oxidising action, and the whole covered with a large glass funnel to guard against subsequent spurting. Strong sulphuric acid is now cautiously poured into the basin, and the latter placed over the flame of a Bunsen burner to concentrate its contents. The quantity of acid added should suffice not only to liberate all weaker acids, but to secure the semi-liquidity of the residue under the funnel when the evaporation has been carried to the extent of evolution of sulphuric acid fumes, and in most cases 50 to 100 grs. will form a suitable quantity. The solution to which the sulphuric acid is added is best to approximate 2 ozs. in bulk, and in about ten minutes has reached the proper degree of concentration. The evolution of sulphuric anhydride is the signal to remove the basin from the source of heat. In this basin, after washing and removing the glass funnel, we have a brown muddy liquid, containing *all* the iodine originally taken as iodic acid, and *absolutely free* from chlorine and bromine. The other constituents are sulphates of manganese and potash, free sulphuric acid, and insoluble manganic oxide, and, in now concluding with the actual estimation of the iodine, we meet with no serious obstacle to its exact gravimetric or volumetric determination. The gravimetric method first to be considered, and also as well the volumetric procedure, necessitate reduction of the oxidised iodine to

hydriodic acid, and, as there is further involved reduction and solution of the insoluble oxide of manganese, the iodine combined therewith as iodic acid passes into solution. Where the original material is of unknown composition, the procedure first to be described is preferably employed to the more expeditious volumetric method: the precipitation of the iodine as silver iodide is open to fewer sources of error, and its capabilities are already in chemical literature pretty well defined. Traces of iodine are further concentrated in a way convenient for corroborative examination. The details are as follows:—

The contents of the basin are diluted with water to reduce the proportion of iodine within 0·16 per cent, and if we avoid exceeding this percentage we are secure against loss of hydriodic acid through volatilisation. Sulphurous acid is now *quickly* added in excess, and the resulting clear solution filtered to separate traces of silica. The filtrate, raised to the boiling-point, but avoiding complete expulsion of the sulphur dioxide, is treated with excess of silver nitrate, and the precipitate thrown on to an ashless filter and well washed. The filter and contents are then dried at any temperature short of charring the filter, and the silver iodide scraped as thoroughly as possible from the paper and weighed. We may arrive at the quantity of precipitate adhering to the filter, either by burning off the paper at the lowest possible temperature and weighing the residue, or by dissolving the silver salt from the filter with an ammonium cyanide solution, evaporating to dryness in a tared platinum capsule, *gently* igniting and ascertaining its weight. I have adopted the latter procedure in the last three experiments of Table II.

Table II.

No. of Exp.	Iodine taken.	Other material taken. Grs.	Iodine found.
I.	0·16 grs.	6KCl+6KBr.	0·15 grs.
II.	0·05 ,,	,, ,,	0·04 ,,
III.	1·22 ,,	,, ,,	1·22 ,,
IV.	3·59 ,,	,, ,,	3·58 ,,
V.	3·59 ,,	,, ,,	3·58 ,,
VI.	2·86 ,,	3KCN.	2·86 ,,
VII.	2·75 ,,	,,	2·76 ,,
VIII.	1·70 ,,	$3KCN+K_6(C_3N_3)_4Fe_2$.	1·71 ,,

The results embodied in this table will, I think, be deemed perfectly satisfactory, and practical chemists will, I imagine, consider them as arrived at in a manner sufficiently simple and convenient. I know of no exception to the applicability of this process in commercial analysis, and granted existence of the iodine material in slightly alkaline solution, and with the addition of such a quantity of permanganate as will ensure the oxidation of all oxidisable material in both alkaline and acid solution, even traces of iodine may be determined with the utmost precision and certainty.

A couple of hours should suffice for the various operations above described, but by the use of the volumetric method which I may now discuss as an alternative procedure for the gravimetric part of the process, this time may be materially shortened.

The volumetric process is designed for, and its application recommended, only in connection with the permanganate and sulphuric acid treatment of the original material, and from the fact of its applicability only to freely acid solutions and of iodine existing as the hydracid, its originality will, I think, be inferred.

In explanation of the principle I may state as follows:—When standard potassium permanganate is run into a hydriodic acid solution containing excess of sulphuric acid, the characteristic pink colour of the permanganate disappears, while hydriodic acid remains to be reacted with and involving chemical changes represented in the accompanying equation —

$$K_2Mn_2O_8+10HI+3H_2SO_4= \\ =K_2SO_4+2MnSO_4+10I+8H_2O.$$

With the liberation of the iodine we have that element communicating to the titrated liquid a deep reddish tint, and consequently the point at which decomposition of the hydriodic acid is complete, and at which the colour of the permanganic acid ceases to disappear, is effectually masked.

To this difficulty, then, of distinguishing the "end reaction," I attribute the hitherto non-application of the facts of the above equation to the volumetric estimation of iodine, and it is in overcoming this difficulty by the simple expedient of titrating the hydriodic acid solution in presence of excess hydrocyanic acid that I now render these facts available in the new volumetric process for iodine. It is well known that hydrocyanic acid in aqueous solution, although chemically inert as regards permanganic acid, reacts actively with iodine, and that the products, cyanogen iodide and hydriodic acid, are perfectly colourless.

It is in this property of decolourising free iodine solutions that hydrocyanic acid finds its function in the volumetric process under discussion, and so effectually is the tinctorial interference of the iodine suppressed, that the "end reaction" is one of supreme sharpness, and the chemical reactions require expression in a new equation—

$$2K_2Mn_2O_8+10HI+10HCN+6H_2SO_4= \\ =2K_2SO_4+4MnSO_4+10CNI+16H_2O.$$

I prepared, for my experiments, solutions of potassium permanganate and hydrocyanic and sulphuric acids. The first mentioned was nearly normal in strength and carefully standardised in the usual way with pure iron in dilute sulphuric acid. One grain of this solution was equal to 0·00619 grs. iodine considered as the hydracid. The hydrocyanic acid solution was simply a moderately strong aqueous solution of potassium cyanide treated with excess of dilute sulphuric acid and tinged a permanent pink colour with permanganate to destroy oxidisable impurity, and the required solution of sulphuric acid was obtained by diluting the strong article with twice its volume of water and colouring likewise with permanganate. The accuracy of the process was first investigated in pure solutions, and a weighed quantity of iodine was dissolved in a little solution of pure caustic soda contained in a glass stoppered bottle, and diluted with several ounces of boiling water. Dilute sulphuric acid and, immediately afterwards, hydrocyanic acid were now added, and the stopper of the bottle quickly replaced to prevent escape of the liberated iodine. (Should that element precipitate in the liquid it is advisable to repeat the experiment with a more liberal addition of the hot water and hydrocyanic acid). The contents of the bottle were kept warm for five minutes to complete the decomposition of the iodic acid, as required by the following equation:—

$$HIO_3+5HI=6I+3H_2O.$$

They were then cooled to the ordinary temperature of the air and titrated with the standard permanganate.

The reaction between the iodine and hydrocyanic acid, to again consider it, is represented in the following equation—

$$2I+HCN=HI+CNI.$$

But under certain conditions of dilution and acidity this reaction may reverse so:—

$$HI+CNI=2I+HCN.$$

The case may be then that in the solution under titration a portion of the iodine may remain uncombined, until, with the progress of the estimation, the amount of hydriodic acid relative to that of the hydrocyanic acid is reduced within a certain proportion. This fact is practically advantageous in enabling us to titrate with freedom while the solution exhibits the slightest iodine tinge.

There is little liability to overstep the point, and excess of even one drop of the permanganate will communicate to the liquid a permanent pink colour. We must take care to ensure a sufficiency of hydrocyanic and sulphuric acids in the solution under titration, otherwise precipita-

tion of either free iodine or manganic hydroxide may ensue. The results of the process, as applied to "pure" iodine solutions, are shown in Table III.

Table III.

Iodine taken.	Iodine found.
1·90	1·90
1·71	1·72
0·21	0·22
19·93	19·88
20·57	20·52
20·75	20·74
2·76	2·76
2·90	2·89
2·21	2·20
2·19	2·19
2·17	2·16
2·21	2·21

In the three experiments footing the list the iodine was completely reduced to hydriodic acid before estimation. Sulphurous acid was employed to effect the reduction, and the excess of reducant expelled by boiling for twenty minutes in a 10-oz. flask closed in the neck with a cork fitted with an exit tube. The proportion of iodine in the boiling solution was kept within 0·16 per cent, and cooling and titration was effected without delay to minimise the oxidation of the hydriodic acid by exposure to the air. As cyanogen iodide is reducible by sulphurous acid to hydrocyanic and hydriodic acids, the iodine of the titrated solution may be re-estimated again if desired. I append, now, Table IV., in which the results are obtained by conjoining the volumetric process with the permanganate and sulphuric acid treatment of the original material. That original material must be free, I need scarcely say, from compounds of iron, copper, &c., capable of forming solutions reducible by sulphurous acid to the subsequent reduction of the standard permanganate. It will be advisable to test the reagents in a blank experiment, my permanganate of potash, for instance, containing traces of iron.

Table IV.

Iodine taken.	Other substances taken.	Iodine found.
2·44 grs.	10KCl+10KBr+3KCN.	2·46 grs.
4·20 ,,	10KCl+10KBr.	4·19 ,,
0·16 ,,	,, ,,	0·16 ,,
0·07 ,,	,, ,,	0·07 ,,

From the presence of the sulphates of manganese and potash in the experiments of this Table the end reaction of the volumetric process was barely so sharp. The pink colour exhibited a tendency to fade semewhat rapidly, but, as is well known, permanganic acid is more liable to spontaneous decomposition in presence of metallic salts. I have experimentally ascertained that in solutions of all bodies excepting those, of course, which either oxidise hydriodic acid, reduce iodine, or form insoluble iodides in acid solution, which, when tinted with one drop of standard permanganate retain their pink colour for a quarter of a minute or so, hydriodic acid may be titrated with exactness. Perfectly satisfactory results have been obtained in presence of sulphates of ammonia, iron, zinc, copper, cobalt, and chromium, &c.

Hydrobromic acid is inadmissible in even small proportion. Moderate quantities of hydrochloric acid would seem, on the contrary, to be harmless. I have repeatedly and accurately titrated hydriodic solutions containing even one-sixth their volume of strong hydrochloric acid.

I have now exhausted the facts of my work on the estimation of iodine. The principle of the volumetric method will, I think, find a wide field of usefulness in volumetric analysis, and, I trust, leisure permitting, to develop its capabilities in future papers.

Laboratory of Clyde Iron Works
(by Tollcross), Glasgow

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, January 19th, 1888.

Mr. William Crookes, F.R.S., President, in the Chair.

Mr. J. Garnett Heywood was formally admitted a Fellow of the Society.

The President announced that the Council nominated as Foreign Members Professors Geuther, Ladenburg, Landolt, Nilson, Van't Hoff, Wislicenus, and Mons. Lecoq de Boisbaudran; and that these would be balloted for at the next meeting.

Certificates were read for the first time in favour of Messrs. William Herbert Barraclough, Westfield House, Thorpe Hesley, near Rotherham; Thomas Fraser Barbour, 16, Gladstone Terrace, Edinburgh; Henry Dudley Berridge, 203, Bellevue Road, Leeds; Alfred Edward Carey, M.Inst.C.E., 9, Dean's Yard, Westminster; Lewis Smith Cocking, Martin Bank, Huddersfield; Walter Hepworth Collins, 14, Bradford Chambers, Mawdsley Street, Bolton-le-Moors, Lancashire; Astley Cooper, 66, Queen's Road, Headingly; John H. J. Dagger, 3, West Bank Road, Edge Lane, Liverpool; Benjamin Henry Gerrans, Jun., 47, Aubert Park, Highbury, N.; Christopher James, Ida Villa, Swansea; J. Lewkowitsch, 6, Warwick Place, Leeds; Charles Robert Lafosse, Knolls House, Hr. Broughton, Manchester; Frederick K. S. Lowndes, 4, Plumstead Common Road, Woolwich; Thomas Maben, 2, Eskdaill Terrace, Hawick; James Mayne, 203, Oxford Street, Sydney, New South Wales; Otto Overbeck, Wootton Bassett, Wilts; Clifford Richardson, Office of the Engineer Commissioner, Washington, U.S.A.; Robert Mason Sumner, 50, Lord Street, Liverpool; Sam. Smith, 30, Commercial Street, Batley, Yorkshire; Angus Smith, 5, Antigua Street, Greenock; Arthur J. C. Waterland, Sidney Villa, South West Road, Leytonstone; John Cuthbert Welch; Emil A. Werner, 5, Church Avenue, Rathmines, Dublin.

The following papers were read:—

1. "*Morindon.*" By T. E. Thorpe, F.R.S., and W. J. Smith, M.B.

The authors have confirmed the observations of Thorpe and Greenall (*Chem. Soc. Trans.*, 1887, 52) on Morindon. Morindin, the active colouring-matter of A'l, the root-bark of *Morinda citrifolia*, yields 48·4 per cent of morindon on hydrolysis. This latter substance is not identical with alizarin, but has the composition $C_{15}H_{10}O_5$, and differs from all of the eight compounds of the same formula which are known at present.

That morindon is a methylanthracene-derivative has been proved by distilling it with zinc-dust. The methylanthracene so obtained was oxidised by chromic acid to anthraquinonecarboxylic acid having all the properties described by Liebermann.

2. "*Manganese Trioxide.*" By T. E. Thorpe, F.R.S., and F. J. Hambly.

The authors have repeated the experiments of Franke (*Journ. fur Prakt. Chemie*, 1887) on the so-called volatile oxides of manganese. They have been unable to obtain any evidence of the existence of the blue gaseous manganese tetroxide. They find, however, that *manganese trioxide* exists and can be formed by the action of a solution of potassium permanganate in sulphuric acid on dry sodium carbonate. It is a reddish-pink amorphous solid, extremely deliquescent, and stable only at a low temperature. On heating it is at once decomposed into manganese dioxide and oxygen. Water decomposes it into manganese dioxide and permanganic acid.

3. "*Note on Chatard's Process for the Estimation o Small Quantities of Manganese.*" By the same.

The authors find that the inconvenience arising from

the formation of lead carbonate in the titration of permanganic acid by ammonium oxalate may be obviated by adding sulphuric acid when boiling with the lead dioxide and nitric acid without impairing the accuracy of the results.

Discussion.

In reply to a question by the President, Mr. Hehner said that Chatard's method was an extremely delicate one; using it in the form of a colorimetric process, he had been able to detect manganese in a few m.grms. of steel containing only half a per cent of manganese.

Professor Thorpe, also in reply to the President, said that there was no reason to believe that any volatile oxide of manganese existed. Chatard's was essentially a minimetric method, and gave highly satisfactory results with very small quantities of manganese.

4. "*Contributions to the Theory of the Vitriol-chamber Process.*" By G. Lunge.

The theory has been recently advanced by Raschig that the vitriol-chamber process involves the formation in the first instance from nitrous acid and sulphurous acid of dihydroxylaminesulphonic acid, which, being acted on by nitrous acid, yields sulphuric acid and nitric oxide; this nitric oxide he considers is then re-converted into nitrous acid. This theory is regarded by the author as untenable on all points. It completely ignores the existence of nitrosyl sulphate (chamber-crystals); moreover, according to Raschig's own investigation, the dihydroxylaminesulphonic acid, as it could not possibly meet at all points with nitrous acid, would yield N_2O, of which a very large quantity would be found in the chambers, which is never the case; lastly nitric oxide, oxygen in excess, and water do not yield nitrous acid but nitric acid. Raschig's indirect proofs are equally unsatisfactory, and would at most only show that subsidiary reactions may take place to a small extent.

A true theory of the vitriol-chamber process must deal with the substances actually present and with reactions fully proved to take place. It has been already foreshadowed by the author (*Chem. Soc. Trans*, 1885, 470) in these words: "It is not, as hitherto generally assumed, NO, but N_2O_3, which acts as carrier of the oxygen in the vitriol chamber, &c." The principal reactions are:—

$$2SO_2+N_2O_3+O_2+H_2O=2SO_2(OH)(ONO).$$
$$2SO_2(OH)(ONO)+H_2O=2SO_2(OH)_2+N_2O_3.$$

These reactions are modified in the first part of the chambers by the excess of SO_2; in the last part sometimes by the complete absence of SO_2; and in some places by an excess of water. No theory can be accepted which assumes the formation of NO_2, since this gas does not occur at all in normally working chambers, and since its formation is practically excluded by the conditions which obtain in the end chambers. The question whether N_2O_3 exists as a gas or not plays only a secondary part in this discussion; but the phenomena occurring in the vitriol-chambers make it at least more probable that N_2O_3 must exist as a gas for some time before it is dissociated. At all events the gas present in the back chambers has a composition equivalent to N_2O_3, and this or NO(OH) must be introduced into the reactions. The direct reactions:

$$SO_2+N_2O_3+H_2O=SO_2(OH)_2+2NO,$$

and—

$$4NO+O_2=2N_2O_3,$$

cannot any longer be considered as important, since nitric oxide and oxygen do not yield N_2O_3 except in immediate contact with sulphuric acid—when $SO_2(OH)(ONO)$ is formed; apart from this, NO_2 must be formed in dry places, or NO_3H in the presence of water, but the presence of SO_2 modifies everything.

In the front chambers there is much NO_2 present along with N_2O_3. NO is formed by a secondary reaction (denitration) from nitrosyl sulphate:

$$2SO_2(OH)(ONO)+SO_2+2H_2O=3SO_4H_2+2NO,$$

and is principally absorbed by the direct reaction—

$$4SO_2+4NO+3O_2+2H_2O=4SO_2(OH)(ONO);$$

none of it can pass into NO_2, but some of it may pass into NO_3H, which is at once acted upon by SO_2, and converted into nitrosyl sulphate. Thus the normal vitriol-chamber process is not as hitherto understood, an alteration of reductions and oxidations, but it is a *condensation* of nitrous acid, or of NO with SO_2 and O_2 to nitrosyl sulphate, and a splitting up of the latter into sulphuric acid and N_2O_3.

Abnormally, N_2O can be formed by the reduction of NO by SO_2, but not according to Raschig's theory. This reaction in properly working chambers does not exceed an extent of 0·5 part of $NaNO_3$ on 100 of S.

Much larger losses are sometimes caused by the abnormal formation of NO_2 in the back chambers, which is due to an abnormally great supply of nitre. In this case the acid-forming process is finished too soon; the N_2O_3 does not meet with any more SO_2, and thus finds time to dissociate into NO and NO_2. Another abnormality is caused by a deficiency of nitre, which leads to losses in the shape of N_2O, of NO, and of NO_3H. Much importance is due to the fact that the normal working of the acid-forming process is a mass reaction, requiring a great excess of oxygen, without which the denitrating reactions, normally prevailing in the front chamber, set in abnormally in the back chamber. This leads to an explanation of the fact why larger chamber-space and a more copious supply of nitre compensate each other to a certain extent.

Discussion.

Dr. Alder Wright thought that an argument might perhaps be adduced in favour of the predominance of NO in the earlier chambers of a series as compared with N_2O_3, from the colour of the gases, the pale colour of which (as contrasted with the tint that would be seen were all nitrous fumes present as N_2O_3) would suggest that only a small fraction of the gases was in the higher state of oxidation. He was disposed to believe that in the chambers themselves *sulphur dioxide* was capable of reducing higher oxides of nitrogen not only to NO but even to N_2O and N_2. This was generally considered to be brought about in the Glover tower in virtue of the higher temperature, and also of the presence of As_2O_3 from pyrites; but as nitrous fumes were known to be destroyed (presumably by reduction) when no Glover tower was used, and with brimstone acid where little or no arsenic was present, it appeared to him that some other source of such loss must be looked for, and that this was to be found in the power of sulphur dioxide to reduce oxides of nitrogen to nitrous oxide at a lower temperature than usually supposed possible.

Professor Ramsay said that Dr. Lunge's remark that nitrous anhydride might act as such, or as a mixture of nitric oxide and peroxide, is, so far as the last statement is concerned, in complete accordance with Professor Ramsay's experience. A mixture of NO_2 and NO in the proportion necessary to form N_2O_3 will act as such with such reagents as water or sulphuric acid. With regard to Dr. Wright's remarks on the production of nitrous oxide, Professor Ramsay had heard from alkali makers that when "things went wrong," *i.e.*, when excess of sulphur dioxide was present, such reduction does take place.

PHYSICAL SOCIETY.

January 28th, 1888.

Prof. W. C. Adams, F.R.S., Vice-President, in the Chair.

In opening the procedings the Chairman referred to the great loss which the Society had sustained by the death of Dr. Balfour Stewart, their late President, and said his loss would be deeply felt by the whole scientific world.

The following papers were read:—

"*On the Effect of Magnetisation on the Thermo-electrical Properties of Bismuth.*" By Mr. Herbert Tomlinson.

It has been shown, by Sir Wm. Thomson and others, that the electrical resistance of an iron wire is increased when magnetised longitudinally, and similar phenomena were shown to occur in steel, nickel, cobalt, and bismuth, in a paper communicated to the Royal Society in 1882 by the author.

On comparing the results it is found that for the same intensity of magnetisation the increase of resistance of bismuth is about two thousand times that exhibited by iron. The author believes the increase of resistance of bismuth to be partly *apparent* only, and thinks that some influence similar to an opposing E.M.F. is operative, but as to its exact nature he can say nothing. Hall's phenomenon suggests itself as a possible explanation, but experiment shows that this is not the true cause. The change of dimensions due to magnetisation is found to be too small to produce the effect, and so far no satisfactory explanation has been found. On heating a rod of bismuth when under the influence of magnetising force an E.M.F. is set up from unmagnetised to magnetised across the hot junction, having a value of about 0·0022 microvolt per 1° C. difference of temperature, when the magnetising force was 226 C.G.S. units. Ettinghausen has found that a difference of temperature is produced between the two sides of a plate of bismuth placed in a magnetic field, when an electric current is passed through it, and it has also been shown that if a thermal current be substituted for the electric current a difference of potentials is produced.

"*On the Influence of Magnetism and Temperature on the Electrical Resistance of Bismuth and its Alloys with Lead and Tin.*" by M. Ed. von Aubel.

An abstract was read by Mr. Baily. Some specimens of bismuth show an increase of resistance with temperature, whilst others show a decided decrease. M. Righi is of opinion that the decrease is due to the presence of tin, but the author's experiments on alloys show that this is not the case. Magnetism always produces an increase of resistance, but its influence diminishes as the temperature rises. It is concluded that the cause of the anomaly is still to seek.

"*On a Water-Dropping Influence Machine.*" By Prof. S. P. Thompson, D.Sc.

In this apparatus only one jet of water is required, and satisfactory results are obtained without special insulation. It consists of three cylindrical metal vessels hung vertically over each other by silk strings, the highest and lowest being connected by a stiff metal wire. The highest is a small cylinder open at both ends; the lowest is an open pot which receives the water. The intermediate vessel is open at the bottom, and is provided at the top with a funnel fixed so that its central aperture is about the middle of the cylinder. The water jet, which must have a fine orifice, is inserted about half way into the uppermost vessel.

"*On the Price of the Factor of Safety in Lightning-Rods.* By Prof. S. P. Thompson."

It is shown, upon certain assumptions, that the safety against fusion varies, as—

$$\text{Total cost } x \frac{f\,r}{\rho\, d\, l^2\, \kappa},$$

where f = temperature of fusion of material above atmosphere, r = specific thermal capacity, ρ = specific electric resistance, d = density, κ = cost in pence per lb., and l = length of the conductor. If the total cost and length are supposed to be given, the factor of safety $= \frac{f\,r}{\rho\, a\, \kappa}$. Of the common metals iron has the greatest factor of safety, being more than four times that of copper. Such being the case the author thinks it desirable that the report of the Lightning Rod Conference be reconsidered.

"*On the Optical Demonstration of Electrical Stress.*" By Prof. A. W. Rücker. F.R.S., and Mr. C. V. Boys.

A number of lecture experiments were shown, illustrating that electrical stress exists in the dielectric separating two charged bodies. The bodies were placed in carbon disulphide, between two crossed Nicols, and on electrifying them by means of a Holtz machine light passed through the analyser. Two concentric cylinders gave a black cross on the screen, similar to those seen on interposing a plate of some uniaxal crystal, and a model illustrating a charged Leyden jar was shown.

CORRESPONDENCE.

INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—I have given notice to bring forward, at the first meeting of the new Council, a scheme for altering the basis of entrance to the Institute.

At the present time it is necessary that any candidate for the Associateship should have studied Chemistry at one of a limited number of schools or colleges, so that any student having received his chemical education—however thorough it might have been—in any other school, college, or private laboratory, is ineligible, however willing he may be to pass the most stringent examination.

I shall be glad if any of the members of the Institute who sympathise with the idea of altering this regulation, and who have not previously communicated with me, would be good enough to give me their views as early as possible, so that I may have their moral support in bringing this matter before the Council.—I am, &c.,

William Thomson.

Royal Institution Laboratory,
Manchester, January 31, 1888.

GAS LIQUOR.

To the Editor of the Chemical News.

Sir,—The following is an analysis of a sample of "gas liquor" obtained from the Gas Works, Bradford, done in duplicate by the undermentioned, which we forward to you as it may be of interest to some of your readers. Each constituent was estimated directly. The specific gravity was 1·035 at 16° C. = 7° Tw.

The ammonium sulphide was supposed to exist as $NH_4.HS$ and the ammonium carbonate was calculated to the formula $(NH_3)_3.2Cl_2.H_2O(N_3H_{11}C_2O_5)$, although we have no proof as to its existing as such.

The results are in grms. per 100 c.c.

	Kay.	Appleyard.
Total ammonia	2·91	2·98
Volatile ammonia	2·72	2·64
Ammonium sulphocyanate	0·17	0·16
" carbonate ..	5·74	5·722
	(CO_2=3·22)	(CO_2=3·21)
Total sulphur	0·638	0·63645
Ammonium sulphide.. ..	0·936	0·901
	(S=0·585)	(S=0·563)
" sulphite.. ..	0·156	0·152
	(S=0·043)	(S=0·043)
" chloride.. ..	1·05	1·03
" sulphate.. ..	0·0132	0·0133
	(S=0·0032)	(S=0·0032)
" thiosulphate ..	trace	trace
" ferrocyanide ..	0·947	0·998

I am, &c.,

J. R. Appleyard.
P. Kay.

Chemistry and Dyeing Department,
Bradford Technical College, Jan. 23, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 1, January 2, 1888.

On the Speed of Transformation of Metaphosphoric Acid.—Paul Sabatier.—The author proposes the law that the speed of transformation is at every instant proportional to the mass of transformable substance present in the system.

An Alloy of Titanium and Aluminium with Silicon.—Lucien Levy.—This compound forms lamellæ, insoluble in water, alcohol, and ether, of a steel-grey colour, and of the sp. gr. 3·11. They are very brittle, and conduct heat rapidly. The compound burns in oxygen at a red heat. Superheated steam and nitric acid do not attack it, except the latter is heated. Sulphuric and hydrochloric acids attack it slightly in the cold, and more powerfully if heated.

Certain Derivatives of Cinchonine.—E. Jungfleisch and E. Léger.—The authors classify these compounds as bases soluble and insoluble in ether, and promise to give their descriptions at a future opportunity.

Action of Oxalic Acid on Cinchonine in Presence of Oxalic Acid.—MM. Caventon and Girard.—The authors describe one of the products obtained, a base soluble in ether, benzene, acetone, chloroform, and the methylic, ethylic, and amylic alcohols, but scarcely soluble in water. It melts at 125°, and turns the plane of polarised light to the left. Its centesimal composition approximates closely to that of cinchonine.

The Vapour-Density of Aluminium-Ethyl.—MM. Roux and Loüise.—Near its boiling-point it has a normal vapour-density, but at about 250° it begins to decompose, and its density becomes equal to the third of its theoretical value.

No. 2, January 9, 1888.

Researches on Ruthenium, its Oxidation, and the Dissociation of its Dioxide.—H. Debray and A. Joly.—Like osmium, ruthenium may be separated by volatilisation from the other metals of the platinum group. The physical properties of this metal are found very different from those attributed to it by Claus. Its specific gravity is found to be 12·261 instead of 8. If metallic ruthenium is heated to a bright redness in the muffle it is at first rapidly oxidised, and assumes the blue colour characteristic of the dioxide. Afterwards the absorption of oxygen becomes extremely slow, and the complete conversion of the metal into RuO_2(Ru = 52) requires an increase of weight of 23·53 per cent. The formation of a sesquioxide is not admissible. If the powdered metal is heated in a slow current of oxygen at a temperature above the melting-point of silver, the whole mass becomes crystalline and a portion sublimes and is deposited in fine crystals on the sides of the tube. If the speed of the current of oxygen is increased progressively we perceive the odour of ozone or of perruthenic acid, and at last this acid distils over, and may be collected in a receiver embedded in ice. This formation of hyper-ruthenic acid requires a temperature exceeding 1000°. In the tube there is found, beside a ring of crystalline dioxide, another deposit, black and amorphous, produced at a lower temperature. The reactions of this compound identify it with a substance more highly oxidised than the dioxide, and obtained by the decomposition of hyper-ruthenic acid. Although it is obtained at very elevated temperatures the dioxide is dissociated above 1000°.

On the Ferric Phosphates and the Alumina Phosphates.—P. Hautefeuille and J. Margottet.—The authors show that a solution of silica in ter-hydrated phosphoric acid, if kept for some days at a temperature of 125°, deposits a crystalline hydrated phosphate. If kept below 125° the same solution deposits the anhydrous phosphate, which crystallises, according to the temperatures at which it is kept, in four forms mutually incompatible. The solutions of ferric oxide and of alumina in phosphoric acid present analogous phenomena. At 100° ter-hydrated phosphoric acid dissolves up to 15 per cent of ferric oxide and up to 8 per cent of alumina. If kept at 100° these solutions, in a few hours, deposit well-defined crystals. Those of iron are of a faint rose colour, and form rhombic tables derived from a klino-rhombic prism. Alumina forms colourless prismatic crystals. If the solutions of iron and alumina are quickly raised to and kept at temperatures between 150° and 200°, both bases yield crystals containing only two-thirds of the water present in the former. Those of iron form rectangular laminæ of a nacreous lustre, which act strongly upon polarised light. The crystals of alumina under the same circumstances are long doubly refractive needles. If the solutions have been kept at temperatures above 200° both the ferric and the aluminous solutions deposit anhydrous salts, which differ in crystalline form according to the temperature, but which are alike in their chemical composition.

The Use of Sulphuretted Hydrogen for purifying the Salts of Cobalt and Nickel.—H. Baubigny.—This paper will be inserted in full.

New Method of Determining Nitrites.—A. Vivier.—(See p. 33).

Action of Formic Acid upon French Oil of Turpentine.—J. Lafont.—Formic acid yields, with French oil of turpentine, reactions varying according to the process adopted for bringing the two substances into reaction. At 100° almost the sole product obtained is a polymeric carbide, diterpilene, without any rotatory power. In the cold, and on moderating the reaction, terpilene formiate is obtained in abundance, and along with it the diformic ether of terpene and a small quantity of diterpilene having a levo-rotatory action.

Synthesis in the Quinoleine Series Effected by Means of Acetylacetone and its Derivatives.—Alphonse Combes.—The substances obtained are $\alpha\gamma$-dimethyl-quinoleine and $\alpha\beta\gamma$-trimethyl-quinoleine.

Revue Universelle des Mines et de la Metallurgie. Vol. xxii., No. 2, September and October, 1887.

This issue contains no chemical matter.

MISCELLANEOUS.

The Use of E.P.S. Storage Batteries for Telegraphic Purposes.—The Exchange Telegraph Company have for six months past employed storage batteries to work the Stock Exchange "tapes" from their office in Cornhill. Two thousand primary batteries were formerly required, but their work is now adequately performed by 210 "E.P.S." accumulators, arranged in three series of 70 each. Mr. Higgins, who contributes a note to the *Electrician*, upon the subject, says, "That about 72 per cent of the electric energy supplied to the accumulators by a dynamo is returned to work the 'tapes.' This current is much steadier than that obtained from primary batteries, and shows no perceptible variation from day to day. The time necessary for charging may from the number of words transmitted be calculated to within a few minutes daily." This satisfactory application of the "E.P.S." accumulators should lead to their being very largely adopted for telephonic and telegraphic purposes, and the attention of the Post Office authorities to the matter will probably result in greater economy, while the reliability of the arrangement has been proved by Mr. Higgins in actual use for a considerable period.

NOTES AND QUERIES.

Saccharine.—Will some correspondent say if this new substance from coal-tar is being manufactured in this country, and if the manufacturers have the *sole* right. If so, what is their name and address? —A. G. M.

Ink Stains.—Ink blots, marks, &c., may be concealed by applying Chinese white once or oftener. This is very effective, and saves injury to the paper from attempts to scratch out such blots or marks. —G. A. KEYWORTH.

MEETINGS FOR THE WEEK.

MONDAY, Feb. 6th.—Medical, 8.30.
— Society of Arts, 8. "Yeast, its Morphology and Culture," by A. Gordon Salamon, F.C.S.
— Society of Chemical Industry, 8. "The Alkaloids, a Review of the Synthetic Methods of Preparing 'Closed Chain' Azo-carbon Compounds," by Dr. H. E. Armstrong, F.R.S. "Studies in Coal Distillation," by Lewis T. Wright, C.E.
— Royal Institution, 5. General Monthly Meeting.
TUESDAY, 7th.—Institution of Civil Engineers, 8.
— Pathological, 8.30.
— Royal Institution, 3. "Before and After Darwin," by George John Romanes, F.R.S.
— Society of Arts, 8. "British Columbia," by Henry Coppinger Beeton.
WEDNESDAY, 8th.—Society of Arts, 8. "The Continuation of Elementary Education," by W. Lant Carpenter, B.A.
— Geological, 8,
— Microscopical, 8.
— Pharmaceutical, 8.
THURSDAY, 9th.—Royal, 4.30.
— Royal Society Club, 6.30.
— Telegraphic Engineers, 8.
— Mathematical, 8.
— Royal Institution 3. "Early Secular Choral Music," by Prof. Hubert H. Parry, M.A.
— Society of Arts, 8. "Etching and Mezzo-Tint Engraving," by Prof. Hubert Herkomer, A.R.A.
FRIDAY, 10th.—Quekett Club, 8.
— Astronomical, 8.
— Royal Institution, 9. "Safety Lamps in Collieries," by W. H. Preece, F.R.S.
— Society of Arts, 8. "The Work of the Afghan Frontier Commission," by Capt. Manifold, R.A.
SATURDAY, 11th.—Royal Institution, 3. "Experimental Optics," by the Right Hon. Lord Rayleigh.
— Physical Society, 3. Annual General Meeting. "On the Limit of Refraction in relation to Temperature and Chemical Composition," by T. Pelham Dale.

CENTRAL INSTITUTION
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TECHNICAL CHEMISTRY.—A Course of Lectures on the Chemistry of OILS (Mineral and Vegetable) and FATS, by Dr. A. K. MILLER, Assistant in Research Laboratory, will commence on Monday, January 23rd, at 4 p.m, Fee for the Course, £1.

For further particulars apply at the Central Institution, Exhibition Road, S.W

PHILIP MAGNUS, Organizing Director

BOROUGH OF BIRMINGHAM.
GAS DEPARTMENT.

The Gas Committee of the Corporation of BIRMINGHAM are prepared to receive Tenders for the Tar to be produced at their various Works from the 30th of June next, for a period of one or two years, or for one year and then subject to termination of the contract on three months' notice on either side.

The quantities to be dealt with in the year ending 30th June, 1889, are estimated as follows:—

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Borough Gas Office, Council House,
Birmingham, December 31, 1887.

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THE CHEMICAL NEWS.

Vol. LVII. No. 1472.

ON THE

SPECTRUM OF THE OXYHYDROGEN FLAME.*

By G. D. LIVEING, M.A., F.R.S., Professor of Chemistry, and J. DEWAR, M.A., F.R.S., Jacksonian Professor, University of Cambridge.

In a former communication the authors described simultaneously with Dr. Huggins the strongest portion of the spectrum of water; subsequently they described a second less strong but more refrangible section of the same spectrum. M. Deslandres has noticed a third still more refrangible section. The authors now find that the spectrum extends, with diminishing intensity, into the visible region on the one hand, and far into the ultra-violet on the other. These faint parts of the spectrum they have photographed, using the dispersion of a single calcite prism and a lengthened exposure; and in the present communication they give a map of the whole extent observed, and a list of wave-lengths of upwards of 780 lines.

The spectrum exhibits the appearance of a series of rhythmical groups more or less overlapping one another, and the arrangement of the lines in these groups is shown to follow, in many cases, the law that the distances between the lines, as measured in wave-lengths, are in an arithmetic progression. M. Deslandres had previously announced that the succession of lines in A, B, and α, follow this law when their distances are measured in reciprocals of wave-lengths, and he has stated that the groups A, B, and α have counterparts in the spectrum of water. The authors find a striking resemblance between those groups and certain parts of the water spectrum, but no exact correspondence.

Dr. Grünwald, of Prague, predicted on theoretical grounds that certain lines would appear in the spectrum of water, and the authors have found a considerable number of lines which tally closely with Dr. Grünwald's predictions, some of them, in the extremities of the spectrum, being the strongest lines observed in those regions.

ON THE

PRECIPITATION OF HOP-BITTER BY LEAD ACETATE.

By ALFRED H. ALLEN.

I have read with some surprise the contribution of Mr. J. O. Arnold, entitled "Note on Mr. Allen's Method for the Detection of Hop-Substitutes in Beer," published in the Chemical News (vol. lvii., page 33). I suppose professional inexperience is the only excuse which can be made for Mr. Arnold.

Mr. Arnold bases his criticism and his three experiments on a paper by me, published in the *Analyst* for June, 1887, a copy of which Journal I enclose. Mr. Arnold is evidently familiar with the original, as he quotes several passages therefrom, and he states that I therein announced that I had "discovered a process" . . . "which is merely a slight modification of a very ancient method." This process he then describes as consisting in the precipitation of the solution with lead acetate, the removal of the excess of lead from the filtrate by sulphuretted hydrogen, and the extraction of any unprecipitated bitter principles from the concentrated solution by agitation with chloroform and ether.

It may seem almost incredible to your readers, but it is nevertheless the fact, that, notwithstanding Mr. Arnold's statement, I never claimed to have made a "discovery" at all in connection with the above process. On the contrary, after some preliminary remarks, I referred to a list of articles in English periodicals, &c., connected with the detection of hop-substitutes in beer. I added that "*they* have formed the foundation of the following statements and proposals." Then, after describing in outline the methods of Dragendorff, Wittstein, and Enders, two of whom employ lead acetate, and who describe the use of immiscible solvents, such as chloroform, &c., I used the following words:—"Several of the writers on the subject state that on precipitating a beer with basic acetate of lead the hop-bitter is wholly precipitated, and hence if the concentrated filtrate has a bitter taste the presence of some hop-substitute is certain. This distinction between the bitter principles of hops and hop-substitutes is referred to in the work entitled 'Chemistry applied to the Arts and Manufactures,' edited by Chas. Vincent, and often described as the 'New Edition of Muspratt's Chemistry.' The process is also described in Wynter Blyth's work on the 'Analysis of Food,' and forms an essential part of Enders's method of detecting bitter substances, so that there is a very general consensus of opinion as to the value of the test."

With this tolerably complete acknowledgment of previous workers before him, Mr. Arnold says I announced that I had "discovered" a process which was "merely a slight modification of a very ancient method"; and further, to give the impression that I claimed the method as my own, he actually entitles his paper a "Note on Mr. Allen's Method," &c.

There being such a uniformity of opinion as to the value of the method, I contented myself with proving its power to remove hop-bitters from a limited number of beers and infusions of hops, while finding that the like principles of all, or nearly all, hop-substitutes are unprecipitated by bad acetate. Since then, however, Dr. W. Johnstone has thrown doubt on the reliability of the method, in a paper published in the *Analyst* for December, 1887. As a consequence of Dr. Johnstone's results I exchanged samples with him, and read a further note on the subject before the Society of Public Analysts, on Jan 11th. This note is already in print, and will probably be published before this sees the light. It is interesting to note that the nature of my most recent results were brought to Mr. Arnold's notice only a few days after the professed date of his paper, and some *ten days before* its publication in the Chemical News.

The following is an extract from the "Laboratory Note" referred to:—

"I examined a sample of hops which had been used by Dr. Johnstone in his experiments, and found that the treatment with lead in the manner described by me did not remove the whole of the bitter. On the other hand, I sent a portion of a sample of hops which I had already submitted to the process with satisfactory results to Dr. Johnstone, when, curiously enough, he failed to precipitate the bitter principle although I had succeeded perfectly. In a second portion of hops from the same source, though not strictly the same sample, he also found the process to fail. In the case of this sample, therefore, there is a direct conflict of evidence, Dr. Johnstone failing to make the process answer, whereas I had succeeded. But the fact that such an apparently simple operation could fail in the hands of another chemist seemed to me very serious, and I have consequently submitted to the process some eight or ten additional samples of hops. In most instances the process has succeeded fairly well, though when operating on a considerable quantity of hops the residue has usually retained a slight but distinct bitter taste. In one or two instances, how-

* Abstract of a Paper read before the Royal Society, Feb. 2nd, 1888.

ever, the bitterness has been more strongly marked, as indeed it was in the sample sent me by Dr. Johnstone."

Why the method should fail in some cases and succeed in others I cannot say at present, but may point out that Mr. M. A. Adams, in the discussion on the note in question, stated that in his extensive experience basic acetate of lead never failed to remove the whole of the bitter from hop solutions, while other bitters, except chamomiles, were unaffected. It has occurred to me that this might be due to his different method of operating, which consists in removing the excess of lead by a slight excess of sulphuric acid (instead of sulphuretted hydrogen), evaporating to a small bulk, and tasting the extract without agitating with chloroform. I have tried this plan on a sample of hops which gave a sensibly bitter extract to chloroform when the lead was removed by sulphuretted hydrogen, and found all trace of bitter had disappeared, even when the concentrated solution was agitated with chloroform, and the evaporated chloroform solution tasted. It appears probable, therefore, that such traces of the hop-bitters as escape precipitation with lead are destroyed by the evaporation with very dilute acid. It remains to be seen whether similar treatment seriously affects the bitter principles of hop-substitutes. In some cases it is to be feared that it will.

The upshot of the matter is that more extended experience shows that acetate of lead cannot be relied on to remove all the bitter principle of the hop from an infusion containing it, especially when the delicacy of the method is increased by extracting the remaining traces of bitter with chloroform, instead of simply tasting the concentrated filtrate.

Sheffield, January 31, 1888.

CONTRIBUTIONS TO OUR KNOWLEDGE OF THE ELEMENT SILICON.

By H. N. WARREN, Research Analyst.

The following is an outline of a new method of preparing silicon, together with a few recent researches on the same, which designates forcibly the allotropic modifications of this element and its different properties.

For the preparation of amorphous silicon, commercial silicon eisen, cast into small bars, was suspended in a line connected to the positive wire of two ferric chloride cells, and immersed in sufficient dilute sulphuric acid for its complete solution, and in close contact with a large platinum plate connected to the negative wire. After the lapse of several hours' duration the iron had completely dissolved, leaving a residue of graphite, together with silica and amorphous silicon. The residue, after being collected and dried, was introduced into a stout glass combustion-tube, heated to redness, and a stream of carbonic anhydride maintained for some time, in order to render the silicon more dense and at the same time to deprive it of its pyrophoric nature and consume a considerable quantity of the graphite. It was afterwards introduced into an iron pipe, screwed at both ends and in contact with metallic zinc; the whole was then heated for two hours' duration to a full red-heat, cooled, and opened, the button of zinc dissolved in hydrochloric acid, when the silicon separated in the crystalline condition. A further quantity was simultaneously converted into graphitoid silicon, by fusing at a full white-heat in contact with aluminium, and parting by means of acid. Both specimens produced were identical in properties to those obtained by the ordinary method of reduction by means of sodium and potassium silico-fluoride.

It may be worthy of note that the three modifications of silicon may be converted by suitable means from the crystalline to the graphitoid, and even to the amorphous, or *vice versâ*. Thus by acting by means of an intense heat with aluminium upon potassium silico-fluoride, the whole of the silicon produced appears in the graphitoid form, but by employing an alloy of tin with 10 per cent of aluminium the reduced silicon assumes the crystalline form, tin apparently playing the same function as when metallic zinc is employed; and by employing a very small quantity of aluminium, without any tin, the silicon separated assumes the amorphous condition.

Again, when an alloy of aluminium and silver is used and a most intense white-heat is employed, and the product parted by means of nitric acid, I have frequently noticed small quantities of a bright reddish powder separate, resembling amorphous selenium and leaving an ash of silica when exposed to the oxyhydrogen flame, but whether this is a fourth modification of the element remains to be decided.

THE ACTION OF SULPHURETTED HYDROGEN ON ARSENIC ACID.

(Preliminary Notice.)

By LeRoy W. McCay, D.Sc.

When a moderately dilute solution of an alkaline arseniate is rendered distinctly acid with sulphuric acid, and treated with sulphuretted hydrogen water containing less sulphuretted hydrogen than is necessary to form, in accordance with the ordinary text-book equations, the tri- or pentasulphide of arsenic, there is generated, after permitting the tightly-corked flask containing the mixed liquids to stand about twelve hours in a cool dark place, a compound which—judging from a number of qualitative reactions—seems to be sulphoxyarsenic acid.

The following method of procedure was resorted to in preparing the compound:—

Fifty c.m.^{3} of a solution of potassium arseniate, containing 25 grms. of the salt in two litres, were brought into a little flask capable of holding about 200 c.m.^{3}, rendered moderately acid with sulphuric acid, and mixed with 25 c.m.^{3} of sulphuretted hydrogen water containing 0·25 per cent sulphuretted hydrogen. The flask was filled almost full of freshly-boiled water, tightly corked, well shaken, and put away in a dark cool place for twelve hours.

When the cork was removed all smell of sulphuretted hydrogen had disappeared, a piece of paper moistened with nitrate of silver and held over the mouth of the flask for fully five minutes remained unacted upon, nor did 10 c.m.^{3} of the solution when dropped into a little water containing a few drops of sulphate of copper alter in the least the colour of the liquid. The solution in the flask, however, was no longer perfectly clear. A decided opalescence had made its appearance, due to the separation of a small amount of finely-divided sulphur. All attempts to get rid of this sulphur by means of ordinary filtration proved fruitless. I found, however, that by adding a little pure porcelain clay to the liquid, thoroughly shaking and then filtering, a perfectly clear filtrate could be obtained. This filtrate was tested as follows:—

1. To 20 c.m.^{3} sulphuretted hydrogen was added in excess. The solution became light yellow and slightly opalescent, but there was no immediate precipitate. Indeed it was fully an hour before there was any decided evidence of the formation of a precipitate.

2. Thirty c.m.^{3} were rendered strongly acid with sulphuric acid. The solution remained clear, but upon heating to boiling, and keeping in this state for a minute or so, it began to cloud up, and soon a considerable quantity of sulphur separated out. I could not distinguish any odour of sulphurous acid, nor could I ootain a reaction for the same with blue litmus paper. The test-tube containing the liquid was held under the tap until its contents were cold, and sulphuretted hydrogen in excess was then added. An immediate precipitate of trisulphide of arsenic proved the presence now of arsenious acid.

3. Fifty c.m.³ were mixed with a solution of sulphate of copper. In the cold there was no reaction, but upon heating the contents of the beaker to boiling a small portion of the copper was thrown down in the form of a black precipitate.

4. To 50 c.m.³ a sufficient quantity of nitrate of silver was added. There was an immediate formation of a heavy black precipitate. It was filtered off, washed thoroughly, and examined. It gave reactions for silver, arsenic, and sulphur. The filtrate from the same, after the addition of a little more nitrate of silver and an excess of ammonia, was boiled for a few minutes. There was no reduction to metallic silver, and consequently no arsenious acid present.

I desire especially to emphasize the fact that the solution upon which the above tests were performed was *clear,* strongly acid, and absolutely free from uncombined sulphuretted hydrogen.* No sulpho-salts or hyposulphites could therefore have been present. Such being the case, I am inclined to believe that there exists in the solution a compound intermediate between arsenic and sulph-arsenic acids, and that this compound is, in all likelihood, free sulphoxyarsenic acid, a potassium salt of which was actually prepared and analysed, in 1845, by Bouquet and Cloez.† These chemists, however, distinctly state that, owing to the ease with which it decomposes into sulphur and arsenious oxide, the acid corresponding to their salt cannot exist in the free state. I think it likely that, in endeavouring to separate the free acid, they used too concentrated solutions. The body acts as though its formula were of the form $H_3AsO_3{\cdot}S$, corresponding to $As_2O_3{\cdot}S_2+3H_2O$.

I have repeated the above experiment‡ and tests again and again, but the results have always been the same.

The probable existence of such a body as free sulphoxyarsenic acid is of intense interest, inasmuch as its formation during the precipitation of arsenic, by a slow current of sulphuretted hydrogen gas from acid solutions of arseniates, would once and for all solve the mystery which ever since the time of Berzelius has been connected with the action of sulphuretted hydrogen upon arsenic acid.

I am continuing my work upon the subject, and I hope soon to be able to publish more definite results. In the meantime I reserve for myself the right to study the character of this compound, be it what it may, and at the same time investigate the *rôle* it plays in connection with the action of sulphuretted hydrogen upon arsenic acid.

John C. Green School of Science,
Princeton, N.J., January 1, 1888.

ON THE

USE OF SULPHURETTED HYDROGEN FOR PURIFYING THE SALTS OF COBALT AND NICKEL.

By H. BAUBIGNY.

The author has previously shown (*Comptes Rendus*, cv., pp. 751 and 806), that the action of sulphuretted hydrogen upon solutions of cobalt and nickel depends on the conditions of the experiment, and that relatively slight modifications of the medium affect the speed of formation of the one or the other sulphide. We comprehend, therefore, that it is not possible to separate, even approximately, cobalt from nickel, or inversely, in a mixture of the salts of the two metals.

This is the case if we operate with neutral sulphates. The action, more rapid at first for cobalt, begins also with the salt of nickel, as experiment shows. The cobalt sulphide formed intervenes, as it will be further shown, in the action of the sulphuretted hydrogen upon the nickel sulphate, just as does nickel sulphide in an acid solution, and it thus promotes the decomposition of nickel sulphate. In like manner, if the mixture of the two sulphates is made in a slightly acetic solution (3 per cent of the liquid volume) the small quantity of cobalt sulphide formed at first, interfering like the former, the nickel sulphide appears almost immediately.

The only case where we might hope to realise an approximate separation by sulphuretted hydrogen is on previously acidifying with sulphuric acid; since nickel sulphate in a solution saturated with this gas at 0° is transformed at 100° into sulphide in conditions of acidity in which a cobalt sulphate is not decomposed.

The author calls *coefficient of equilibrium* the number expressed by the ratio of the weight of the free sulphuric acid to that of the sulphuric acid of the neutral sulphate in solution. When this ratio is such that the hydrogen sulphide no longer acts upon this salt at 100°, for nickel sulphate its value is about 5, whilst for cobalt sulphate it is only 2·5, when the salts are from 2 to 8 grms. per litre.

In the case of a mixture of the two salts, if a represents the weight of combined acid in the cobalt sulphate employed, and b that of the acid of the nickel sulphate, the weight, M, of free SO_3 corresponding to the coefficient of equilibrium of the system, will be $M=a\times 2{\cdot}5+5\,b$, and consequently, for the whole weight, M′ of free acid in the solution, less than M but greater than M″ if $M''=a+b$, 2·5, it might seem that nickel would separate out alone as sulphate at 100°. Experiment, however, proves that this is not so. The nickel sulphide always contains relatively considerable quantities of cobalt, even if M receives its higher value. Moreover, in this case the weight of the sulphide formed becomes almost null, especially if the proportion of nickel in the saline mixture is sensibly inferior to that of cobalt.

It appears, therefore, clearly, that we cannot, by the action of sulphuretted hydrogen, precipitate either pure nickel sulphide or pure cobalt sulphide from a mixture of the salts of the two metals, even in conditions deduced from comparative experiments made upon each metal separately.

Nevertheless Dallfs, at the Congress of German Naturalists and Physicians in 1879, announced in a memoir on "The Action of Sulphuretted Hydrogen upon the Salts of the Heavy Metals" (1) that cobalt and nickel are not precipitated as sulphides in presence of the strong acids; (2) that in the case when several salts capable of being attacked by sulphuretted hydrogen are jointly present, such metals cannot be simultaneously transformed into the corresponding sulphides, and that the precipitation is always effected in such a manner that *always* one metal is completely precipitated before the separation of another begins. Upon this fact, he adds, may be founded a very convenient method for preparing pure cobalt and nickel. As sulphuretted hydrogen first completely precipitates cobalt acetate, acting upon nickel acetate only afterwards, it is merely necessary to add to the mixed solution of the nitrates of these metals a quantity of sodium acetate insufficient for the total transformation of the nitrates, and then to treat with sulphuretted hydrogen. According to the relative quantities of the two metals and that of the sodium acetate added we shall have either a solution of nickel free from cobalt, or a precipitate of cobalt sulphide free from nickel.

The assertions of Dellfs are erroneous as regards the first point. As to the second we have seen that it is not correct to say that sulphuretted hydrogen acts only in succession upon cobalt and nickel when these two metals are jointly present in combination with one and the same acid. Anthou, who first showed in a general manner that if we place an insoluble metallic sulphide in the solution

* The solution soon becomes opalescent from a separation of sulphur.

† *Annales de Chemie*, Janvier, 1845. *Journ. fur Praktische Chemie*, xxxiii., 2, P. 1.

‡ If hydrochloric acid, instead of sulphuric acid, be used for acidifying the original solution of the alkaline arseniate, the filtrate from the kaolin and sulphur can be tested with barium chloride for sulphuric acid. I have performed this test several times, but in no case have I obtained a reaction for sulphuric acid.

of another metal whose sulphide is more stable in an acid medium, there is effected a double decomposition, has never asserted that this exchange is complete. The author has in several cases proved that the reaction is still incomplete, even after several days.

Further, as it seemed doubtful if, under the circumstances the law of the distribution of acids and bases was not in accordance with the results of the researches of Margueritte and Malagutti, the author thought it necessary to examine if Dellfs had really come upon a special exceptional case. He mixed 11·425 grms. pure anhydrous cobalt nitrate with 2·774 grms. nickel nitrate of the same quality. To the solution were added 13 grms. pure crystalline sodium acetate, so as to convert three-fourths of the cobalt salt into acetate, according to the data of Dellfs. Lastly, the liquid, acidified with 2 c.c. of glacial acetic acid, which could only be favourable to the separation of cobalt sulphide, occupied the volume of 285 c.c. It was then treated with sulphuretted hydrogen and let stand for two hours in a closed vessel before filtering. The mother-liquor was of a rose colour. 50 c.c. of this liquor, after being separately treated with potassium nitrite in an acetic liquid to eliminate cobalt, should have given 0·199 grm. NiO if the reaction had taken place as alleged by Dellfs. But it yielded only 0·051 grm., or about one-fourth.

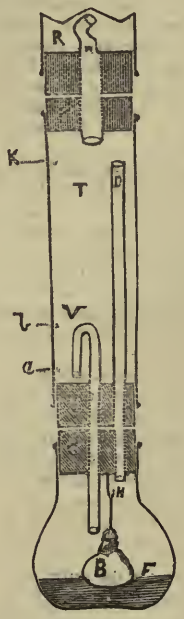
As for the precipitate which ought to have been pure cobalt sulphide, it was methodically washed by detaching it each time from the filter and agitating it with a known volume of water containing 2 per cent of acetic acid and saturated with sulphuretted hydrogen until it ought to have contained, like the mother-liquor, less than half a milligrm. of NiO. But, after drying, ignition, and converting this sulphide into nitrate to separate the cobalt by the method of double nitrite, it yielded 0·750 grm. NiO perfectly free from cobalt. The bulk of the nickel had therefore been precipitated along with the cobalt.—*Comptes Rendus* (cvi., p. 132).

AN IMPROVED MODIFICATION OF SOXHLET'S APPARATUS, FOR THE EXTRACTION OF OIL AND FAT IN PLANTS, FOODS, &c.

By JOHN J. BARLOW, Analytical Chemist.

The apparatus which I have devised, and which is shown in the sketch, is essentially a modification of Soxhlet's. It consists of a flask, F, of about 220 c.c. capacity, into which fits tightly a sound cork, C, pierced with two holes. Underneath, and in the centre of the cork C, is fixed a small hook, H (a pin bent round will do very well): to this hook H is suspended, by means of a platinum wire, a small cotton bag, B, which contains the substance to be operated on. On the top of this flask is a tube, T, about 7 inches long and 1¼ inches in diameter; at each end of this tube is fitted a good sound cork, S and P; the cork S is pierced with two holes, similar in size and position to the holes in the cork C. The holes in these two corks are best made by placing the corks together, end to end, and boring through both corks simultaneously. Into the larger of the holes in S is pushed the tube D, about 6½ inches in length and ¼ inch diameter (internal), and through the small hole in S is pushed the syphon tube V, which is about ⅛ inch internal diameter, and which has been previously bent round in the manner shown; the cork S is now pushed tightly into the end of T; at the top of this tube is fitted another cork, P, which is pierced with a hole in the centre: through this hole the tube W passes into the condenser R.

When operating I take from 2 to 6 grms. of the substance, place on a piece of good calico about 5 inches square (which has been previously well cleaned by boiling in a dilute solution of sodium carbonate, afterwards in water, dried, and weighed); the substance is tied up in this by means of a platinum wire, and then suspended to the hook H; then about 120 c.c. of ether are placed in F, the cork C pushed in tight, with bag underneath; the bottom of the bag must be at least a ½ inch from the bottom of the flask. The tube T is now fixed to the condenser R by pushing the tube W through the hole in the cork P; then the flask is fitted to T by pushing it on to the tubes V and D, the cork C fitting closely up to the cork S; the tube D must only just pass through C, and the tube V much lower. The whole apparatus is now lowered, so that F is immersed in a large beaker or other suitable vessel of water, kept at the temperature of boiling ether. When the ether boils its vapour rises up through the tube D into the condensing tube W, flows back down W, when condensed, into the tube T, where it accumulates until it gets to the bend of the tube V, at *b*, when it will syphon back into the flask, and so on *ad libitum*. After about two hours the beaker of hot water may be removed, and the flask with corks C and S, and the tubes



D and V, taken from tube T: tube V is removed, and then replaced by a larger one, which reaches up to the point K. The apparatus is again connected, and the distillation carried on till the ether fills the tube T to the point K. The flask is now slipped off C, the bag taken from the hook H, and both flask and bag placed in the air-bath, and dried at a temperature of 220° F. until weight is constant. The weight of the flask and its contents, minus the weight of the flask, gives the weight of the oil extracted. The contents of the bag are ready for operating on to obtain indigestible fibre, mineral matter, &c.

The advantages claimed for this arrangement are, 1st, that the tube T, with its fittings, acts precisely as in a delicately made Sohxlet tube, but is not so liable to fracture, is less costly, and can be easily fitted up out of loose material found in most laboratories; 2nd, the substance operated upon is always subject to the action of boiling ether or ether vapour, a point of great importance with some substances, instead of only cold ether as in other arrangements; 3rd, that by means of using a larger syphon tube, after the oil extraction, nearly all the ether can be distilled off and recovered at one operation, and

the whole extraction done in much less time than with cold ether, and with very little loss.

Oak Lane Laboratory, Whitefield, Manchester, January 21, 1888.

LEAD SLAGS.

By MALVERN W. ILES.

(Concluded from p. 45).

ALL of the above-named various types have been made by the writer, and run for some time, except the type A, which it is thought should only be used under exceedingly peculiar circumstances. It must certainly occasion much loss in both lead and silver, and aside from its being an expensive slag where siliceous ores are treated, it is also a dangerous slag to use, owing to the liability of forming "iron sows." It is thought best never to allow the percentage of lime to drop below 10 per cent.

Type B will keep the furnace in good condition and the tonnage large, but the silver and lead losses are also liable to be large. This character of slag is illustrated by analyses 12 and 17 and Fig. *a'*. The crystals are generally small rhombic plates, more or less thickened, and are often hopper-shaped, and are characterised by well-defined striations. There are conditions which make this an exceedingly economical slag. Where good limestone is not readily obtained at reasonable rates this is not a bad slag to make.

Type C, according to Dr. O. H. Hahn, has the formula $6FeO3SiO_2+2CaOSiO_2$; hence the following percentage of composition:—

	Per cent.
SiO_2	30·61
FeO	55·10
CaO	14·29
	100·00

Now, by deducting 10 per cent as an allowance for the other ingredients, there remain—

	Per cent.
SiO_2	27·55
FeO	49·59
CaO	12·86
	90·00

We therefore see that the slag belongs to the type C. This slag has been accurately described by Dr. O. H. Hahn in the *Mineral Resources of the United States* for 1882. The salient features may be briefly stated as follows:—"The proportion of calcic oxide is to the ferrous oxide as 1 : 4;" it has a marked physical appearance, a distinct crystalline form, colour black, "frequently with a rusty brown film, and a fibrous texture;" it is a good slag, both commercially and metallurgically. It is not as free from lead as type E, "and is especially adapted for smelting ores containing a large percentage of zinc." It will be readily seen that where exceedingly siliceous ores are treated, which also contain much zinc, type C cannot be regarded as an economical slag; while in localities where iron flux is abundant and the ores carry much zinc, this slag cannot be too highly recommended.

Type D is well adapted to the treatment of siliceous and very impure ores; it crystallises in the form shown in Fig. *b*, and corresponds to the formula—

$$5FeO4SiO_2+3CaO2SiO_2.$$

This gives as its percentage of composition—

	Per cent.
SiO_2	40·54
FeO	40·54
CaO	18·92
	100·00

It was found that by smelting a certain class of ores the united percentages of SiO_2, FeO, and CaO, as shown by analysis, would be 84; therefore, if we deduct 16 per cent from each of the above given percentages, there would result—

	Per cent.
SiO_2	34·06
FeO	34·06
CaO	15·90
	84·02

or practically—

	Per cen
SiO_2	34·00
FeO	34·00
CaO	16·00
	84·00

It cannot be said that the type D is the same as type F, which it closely resembles in chemical composition, since the crystalline form (Fig. *b*) and physical properties are entirely dissimilar. Very excellent results have been obtained with this slag, even when producing high-grade silver bullion. The crystals of this slag are more or less translucent, flattened, and often contain an abrupt arrow-shaped point or termination. These crystals should not for a moment be confounded with the sharp, blunt, spear-headed slag formation which is due to a marked deficiency in iron (or manganese), since the latter slag invariably contains considerable silver. The chief objection to the type D is the difficulty of obtaining it. When there is a scarcity of both iron and lime, and siliceous ores must be treated, I know of no better slag than that given by type D: these slags will invariably run very low in lead, and the silver will vary from half an ounce to two and a half ounces per ton, according to the grade of bullion and the lead charge.

Type E is a most excellent slag; it is a true singulo-silicate, and has the formula $6FeO,3SiO_2+4CaO,2SiO_2$. This gives as the percentage composition:—

	Per cent.
SiO_2	31·38
FeO	45·18
CaO	23·44
	100·00

By deducting 10 per cent as an allowance for other ingredients we would obtain—

	Per cent.
SiO_2	28·24
FeO	40·66
CaO	21·10
	90·00

It is customary to carry at least 30 per cent SiO_2 in forming this type of slag. The CaO : FeO practically as 1 : 2; the physical properties are well marked, and it crystallises as shown in Fig. *c*.

"If," says Dr. Hahn, "the proper amount of fuel has been given to the charge, it will contain neither lead nor silver; and it is my opinion that if it ever is metalliferous it is through small globules of matte dissolved in it, which have not been separated on account of lack of heat in the furnace. Running on such a slag a furnace can never get out of order except through gross carelessness." I have previously stated that *all* lead slags contain at least *some* lead and silver, although the amounts may be small, perhaps merely a trace; yet I have never seen a slag which at the same time contained only a trace of lead and silver, although I have examined a very large number of slags which were claimed to be free from these elements. This slag is used to "blow in" a furnace, to loosen up crucible obstructions, and also immediately after "barring" the furnace hangings, with markedly good results. It allows a large tonnage, requires a comparatively small

amount of fuel, and is in short an economical slag where it can be continuously run; but in certain localities, where iron flux is quite scarce, it is not as profitable a slag as the types D, F, and G.

Type F is the next well-defined slag in the lime scale (see Fig. *d*, and analyses Nos. 63, 64, 65, 66, 67, 68, and 84). The most perfect crystals I have noticed belonging to this type were carefully analysed, giving the results as stated in analysis No. 84. This is a black, lustrous slag, distinctly resinous. The crystals are rectangular prisms, remarkably translucent, and in fact where there is little manganese present they are often transparent; the tops of a number of the crystals are slightly indented or hollowed out, like salt crystals. It is an exceedingly friable slag; the powder is mouse coloured. I am indebted to Mr. H. V. Furman for a specimen of this slag; to Mr. A. F. Schneider is due the discovery of the type. This slag contained only two-tenths of an ounce silver and one-quarter of one per cent lead, and is the freest from lead and silver of any slag I have ever been able to find.

Type G is perhaps the best slag which has been discovered for the treatment of exceedingly siliceous ores. Mr. Raht, metallurgist of the Horn Silver works, Utah, produced this slag with most excellent results, working ores containing considerable baryta, alumina, and zinc. If I am properly informed, Mr. Raht is the discoverer of this most excellent type, which first gained publicity through an article by Mr. Schneider. This slag crystallises in the form shown in Fig. *e*, and will usually contain from 25 to 30 per cent CaO. The pectolitic forms of these high lime slags are sometimes good.

The slag crystallising in hexagonal plates, as shown in Fig. *g*, is sometimes good, but more often these indicate a bad slag according to my own experience. These hexagonal plates may be regarded as indicative of too high a percentage of lime, in forming the high lime slags. In attempting to flux exceedingly siliceous ores with lime alone, we will obtain slag appearances like Figs. *f*, *f'*, and *h*. But while such slags (notably Fig. *f'*) are remarkably free from lead, the silver is alarmingly high; according to the experience of others, however, the very reverse has been observed. In making this high lime slag, where there is a great deficit in either iron or manganese, the fuel and the lead charge have little or no effect in reducing the silver losses.

In conclusion it should be said that there is unmistakably some law governing the losses of both lead and silver in lead smelting. This law, it seems to me, has never as yet been clearly enunciated. We know that most highly crystalline slags are good, yet some slags which have no well defined crystalline form are also good. Furthermore, it is known that most easily fusible and fluid slags are good, and yet this is not always the case. Why should one slag be good and another be bad? To say that there should be a certain ratio existing between the silica and the bases does not solve the problem. The fuel also has a very important bearing upon this question, and it is well known that coke alone will produce a cleaner slag than a mixture of coke and charcoal. While the use of charcoal will give an increased tonnage, it will also generally cause an increased loss in silver.

The dissemination of matte globules in the slag does not to my mind satisfactorily explain the silver losses, since I have detached perfectly pure crystals from the very heart of the pot from slags of all of the above given types, and as a general thing these crystals were found to contain a larger amount of silver than the main body of the slag; the lead contents will usually be less. It was once thought that silver losses were due largely to manganese by the formation of silicate of silver (that is, the nascent oxygen given off from the manganese oxides would oxidise the silver, and this would unite with silica and thereby be carried off into the slag). I have elsewhere shown the impossibility of this supposition, and that there is no good ground for believing that such a compound has ever been produced or can be.

Can it be possible that the amount of cyanogen existing in the furnace at different times when producing certain types of slag has any bearing upon this subject? Aside from the fact that there are certain well known ratios which should exist between the silica and the bases present (for example, iron and manganese), and that lime has a most remarkable influence in cleansing the slag, we know little or nothing regarding this subject.

There seems to be some law governing the crystalline form and the amount of lime present, and it has been noticed that slags having different amounts of lime usually crystallise as follows (see p. 4 *ante*).

Slags having 3 to 5 per cent CaO crystallise like Fig. *a*.
Slags having 8 to 12 per cent CaO crystallise like Fig. *a'*.
Slags having 15 to 18 per cent CaO crystallise like Fig. *b*.
Slags having 19 to 22 per cent CaO crystallise like Fig. *c*.
Slags having 23 to 25 per cent CaO crystallise like Fig. *d*.
Slags having 25 to 27 per cent CaO crystallise like Fig. *e*.
Slags having 30 to 35 per cent CaO crystallise like Fig. *g*.

And, finally, two slags which have almost the same identical chemical composition will frequently give by assay very dissimilar results.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, February 2nd, 1888.

Mr. William Crookes, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. Thomas Aschroft Ellwood, 46, St. Mary's Terrace, Paddington; James H. Gardiner, 6, Bloemfontein Avenue, Uxbridge Road, W.; Charles E. Munroe, Newport, Rhode Island, U.S.A.; Herbert Trewby, Langford Lodge, Clapham Park, S.W.; Thomas Edward Towerson, care of Messrs. R. Hammond and Co., Bilbao, Spain.

Professors Geuther, Ladenburg, Landolt, Nilson, Van't Hoff, Wislicenus, and Mons. Lecoq de Boisbaudran were elected Foreign Members of the Society.

The following were elected Fellows of the Society:—

Messrs. Edward Arthur Andrews, Samuel Banner, Arthur G. Bloxam, Peter Coulson Bunn, F. Barker Cooke, Albert W. Day, Philip A. Estcourt, William Cay Forsyth, Agnew Griffith, Lewis Walter Hawkins, John B. Kirkland, Thomas A. Lawson, Ph.D., Frank E. Lease, Stevenson J. C. G. Macadam, Edmund G. McBretney, W. Sedgwick Saunders, Frederick W. Shaw, Sidney Skinner, B.A., Charles F. Townsend, Alfred Edwin Tutton.

The following lecture was delivered:—

5. "*The Range of Molecular Forces.*" By A. W. Rücker, M.A., F.R.S.

In discussing the range of molecular forces it is convenient to adhere to the language of the theory of action at a distance, though with full expectation that it will ultimately be replaced by another, such as the vortex-atom theory of Sir W. Thomson, or the granular theory of Professor Osborne Reynolds, which involves only action in proximity.

If we do this, however, it must be admitted that the law of molecular action may be very complicated. It may be granted that we naturally look for simplicity in our fundamental assumptions, but it is certain that we have *à priori* no more right to expect simplicity in the results of the action of a medium than simplicity in its constitution, and that the two are not necessarily obtained together.

The largest values of the magnitude of the radius of molecular action which have been published have been deduced from observations on the condensation of gases and vapours on the surfaces of solids. Estimates on this basis made by Müller-Erzbach (*Exner's Rep.*, 1885, xxi.,

409) and Kayser (*Wied. Ann.*, 1881, xiv., 450) have ranged between 1500 and 3000 micromillimetres* ($\mu.\mu$). Such observations are open to many objections. Bunsen (*Wied.*, 1885, xxiv., 335) has shown that CO_2 will not condense on glass unless a film of water be previously formed. Warburg and Thinori (*Wied.*, 1886, xxvii,, 481, and *Wied.*, 1887, xxxi., 1006) adduce reasons for believing that the water film is largely due to uncombined or loosely combined alkalis on the surface. On clean unvarnished metals, washed glass, and quartz, the thickness of the water film which can be removed by dry air without heating does not exceed 12 $\mu.\mu$. A striking exception was agate, on which films 1640 $\mu.\mu$. thick are stated to have been formed. As this substance, however, is composed of alternate layers of quartz and a porous impure opal, the basis for an accurate calculation does not exist.

On the whole, it seems that no definite conclusions as to the magnitude of the radius of molecular action (ρ) can at present be drawn from these experiments.

Quincke (*Pogg. Ann.*, 1869, cxxxvii., 402), as is well known, by measuring the capillary elevation of liquids between glass plates coated with thin wedged-shaped films, found $\rho = 50$ $\mu.\mu$.

Plateau ("Statique des Liquides," 1873, i., 210) showed that the surface-tension of a soap-bubble, which thinned until its thickness was 118 $\mu.\mu$. was unaltered. He concluded that $\rho < 59$ $\mu.\mu$. Maxwell ("Ency. Brit.," Ed. ix., Art. "Capillary Action"), however, though by a confessedly imperfect theory, shows that the surface-tension may not change until the thickness of the film $= \rho$. Hence plateau's result may mean only that $\rho < 118$ $\mu.\mu$.

Reinold and Rücker (*Phil. Trans.*, clxxvii., Part 2, 1886, 627) have proved that the surface-tension does not alter by 0·5 per cent when the film is so thin as to show the black of the first order of Newton's colours. This appears at first sight at variance with Quincke's result, but their observations are really in remarkable accord with his.

The black and coloured parts of a film are separated by a sharp line, which proves a discontinuity in the thickness (*Proc. Roy. Soc.*, 1887, No. 182, 340). The colours, which correspond to certain thicknesses, which may be called the unstable range of thickness, are always missing.

The black part of the film has been proved by Reinold and Rücker (*Phil. Trans.*, Part II., 1883, 645) to be of a uniform thickness, which differs but little from 12 $\mu.\mu$. Sir William Thomson (*Proc. Royal Institution*) and these observers independently arrived at the conclusion that these curious phenomena are due to the fact that the surface-tension diminishes to a minimum, and then increases again when the thickness is somewhat > 12 $\mu.\mu$.

The colours of the film prove that the upper limit of the range of unstable thickness is between 96 and 45 $\mu.\mu$. Quincke's result indicates that it lies between 100 and 50 $\mu.\mu$., according as we adopt Plateau's or Maxwell's views. These calculations are therefore in complete accord. Quincke's result is not an isolated fact, but is supported by observations on soap-films. The statement that 50 $\mu.\mu$.. and the radius of molecular action are of the same order of magnitude may now, perhaps, rank as an ascertained fact.

Another method of investigating the radius of molecular action is based on the phenomena of electrolytic polarisation, by observing the change in the difference of potential between a metal and a liquid in which it is immersed, when a gas or metal is deposited on it by electrolysis. In the former case we do not know the density of the gas, in the latter Oberbeck (*Wied.* 1887, xxxi., 337) concludes that a plate of platinum is completely polarised by a film of another metal of from 3 to 1 $\mu.\mu$. in thickness. The method of experiment is, however, open to objections which are indicated by Oberbeck himself.

Measurements of the thickness of the double electric layer of Helmholtz, which is closely related to the distance between two consecutive layers of molecules, have been made by Lippmann (*Compt. Rend.*, 1882, xcv., 687) Oberbeck and Falck (*Wied.*, 1884, xxi., 157).

The values they give vary between 1 and 0·02 $\mu.\mu$. Wiener (*Wied.*, 1887, xxxi., 624) has studied the alteration in the phase of light reflected from very thin silver plates deposited on mica. He finds that the effect begins to alter when the thickness is reduced to 12 $\mu.\mu$., and that it was possible to detect a silver film, the thickness of which did not exceed 0·2 $\mu.\mu$.

The diameter of a molecule is a conventional term for the mean distance of the centres of two molecules during an encounter. It may therefore be different in the liquid and gaseous states. Sir William Thomson ("Natural Philosophy," Thomson and Tait, Part II., 295, 1883), as the result of his celebrated discussion of this point, concludes that the mean distances between the centres of molecules in liquids (supposed arranged uniformly) is between 0·07 and 0·02 $\mu.\mu$., and that the latter quantity is an inferior limit to the diameter of a gaseous molecule.

The diameters of molecules (d) may be calculated if we know the mean free path (L), and the so-called condensation coefficient (v), which is the volume of the molecules contained in a unit volume of the gas.

Loschmidt (*Sitzungsber. Wien. Akad. Math. Classe*, lii., abt. 2) and O. Meyer (*Die Kinetische Theorie der Gase*, 225, 1887) have calculated d on the assumption that the molecules in a liquid practically fill the whole space it occupies. Exner (*Rep. der Physik*, xxi., 226, 1885), using a formula given by Clausius, $v = (K - 1)/(K + 2)$, when K is the specific inductive capacity, and which may be replaced by $v = (n^2 - 1)/(n^2 + 2)$, when n is the respective index, finds values of d about five times smaller.

Three independent methods of calculating the diameter of a gaseous hydrogen molecule lead to results between 0·14 and 0·11 $\mu.\mu$. The most reliable conclusions which have been reached as to molecular magnitudes may be summed up in the following table, which is reproduced from a diagram exhibited during the lecture.

$\mu.\mu$.		
118	Superior limit to ρ	Plateau. (Maxwell).
96—45	Range of unstable thickness begins	Reinold and Rücker.
59	Superior limit to ρ	Plateau.
50	Magnitude of ρ	Quincke.
12	Range of unstable thickness ends	Reinold and Rücker.
12	Action of silver plate on phase of reflected light alters..	Wiener.
10·5	Thickness of permanent water film on glass at 23° C. ..	Bunsen.
4—3	Mean distance between centres of molecules in gases at 760 m.m. and 0° C. ..	O. Meyer.
3—1	Thickness of metal films which polarise platinum	Oberbeck.
1—0·02	Thickness of electric double layer	Lippmann and Oberbeck.
0·2	Smallest appreciable thickness of silver film	Wiener.
0·14—0·11	Diameter of gaseous hydrogen molecule	Exner. O. Meyer. Van der Waals
0·07—0·02	Mean distance between centres of liquid molecules..	W. Thomson.
0·02	Inferior limit to diameter of gaseous molecule	W. Thomson.

5. "*A New Method of obtaining Monohydrazides of α-Diketones.*" By FRANCIS R. JAPP, F.R.S., and FELIX KLINGEMANN, Ph.D.

Nitrous acid interacts with ethylic methacetoacetate, forming ethylic isonitrosopropionate, and with methacetoacetic acid forming isonotroso-ethyl-methyl ketone. The

* The micromillimetre is the millionth of a millimetre.

authors recently showed (*Proc.*, 1887, 140) that in the first of these reactions the nitrous acid may be replaced by diazo-salts, in which case an ethylic phenylhydrazine-pyruvate is obtained. They now find that the analogy between nitrous acid and diazo-salts extends also to the second reaction. By acting on sodium methacetoacetate with diazobenzene chloride they have prepared v. Pechmann's monohydrazidodiacetyl :—

$$CH_3{\cdot}CO{\cdot}CH(CH_3){\cdot}COONa + C_6H_5{\cdot}N_2Cl = CH_3{\cdot}CO{\cdot}C{\cdot}CH_3 + CO_2 + NaCl$$
$$\ddot{N}{\cdot}NHC_6H_5.$$

The compound crystallised in short needles, melting at 133°, which agrees with v. Pechmann's determination. With phenylhydrazine it yields a compound melting at 243°, identical with v. Pechmann's dihydrazide of diacetyl m.p. 240°; v. Pechmann).

The authors intend to extend this reaction to other alkyl-acetoacetic acids.

7. "*The Formation of Dihydrazides of α-Diketones.*" By Francis R. Japp, F.R.S., and Felix Klingemann, Ph.D.

The authors find that the compound $C_{16}H_{18}N_4$, which they obtained by heating phenylhydrazinepyruvic (benzene-azopropionic) acid, and which is formed according to the equation—

$$2C_9H_{10}N_2O_2 = C_{16}H_{18}N_4 + 2CO_2 + H_2$$

(*Ber.*, xx., 2943) is identical with the dihydrazide of diacetyl, since prepared by v. Pechmann (see preceding note). Its formation from phenylhydrazine-pyruvic acid may be represented thus :—

$$\begin{matrix} CH_3{\cdot}C : (N_2H{\cdot}C_6H_5){\cdot}\boxed{COO|H} \\ CH_3{\cdot}C : (N_2H{\cdot}C_6H_5){\cdot}\boxed{COO|H} \end{matrix} = \begin{matrix} CH_3{\cdot}C : (N_2H{\cdot}C_6H_5) \\ CH_3{\cdot}C : (N_2H{\cdot}C_6H_5) \end{matrix} + CO_2 + H_2.$$

The authors have prepared the corresponding compounds from the tolylhydrazine-pyruvic acids, and are engaged in comparing them with those obtainable from diacetyl and the tolylhydrazines.

8. "*The Action of Phenylhydrazine on an Unsaturated γ-Diketone.*" By Francis R. Japp, F.R.S., and G. N. Huntly.

The saturated γ-diketones, such as acetonyl-acetone, are known to interact with 2 mols. proportions of phenylhydrazine to form colourless dihydrazides: the authors find that the unsaturated γ-diketone — anhydracetophenonebenzil—behaves differently, thus:—

$$Ph{\cdot}CO{\cdot}CPh : CH{\cdot}CO{\cdot}Ph + C_6H_5{\cdot}NH{\cdot}NH_2 = C_{28}H_{22}N_2 + H_2O + O,$$

the reduction involved in the process being probably effected at the expense of a second molecule of phenylhydrazine. The compound $C_{28}H_{22}N_2$ forms canary-yellow needles, melting with decomposition at 231°, very sparingly soluble in all the ordinary organic menstrua of low boiling-point. The authors regard it as a closed-chain compound, possibly with two nitrogen-atoms in the ring.

9. "*The supposed Identity of Rutin and Quercitin.*" By E. Schunck, Ph.D., F.R.S.

Rutin, a crystalline yellow colouring-matter contained in the leavees of garden rue (*Ruta graveolens*), was discovered by Weiss, and subsequently examined by Bornträger; by Rochleder and Hlasiwetz, who obtained it from capers, the flower-buds of *Capparis spinosa*; by Stein, who found it in Chinese yellow berries, the flower-buds of *Sophora japonica;* and by the author himself, who extracted it from the leaves of *Polygonum fagopyrum*, the common buckwheat. By most of these chemists it was held to be a distinct substance. The experiments of Hlasiwetz, however, seemed to prove that it was identical with quercitrin, and this view appears to have been generally adopted. Quercitrin having within the last few years been examined by Liebermann and others, and its true composition having been ascertained, while rutin, so far as the author knows, has not recently been made the subject of investigation, it was thought that it might be of interest again to compare the two substances, and, if found to be distinct, to ascertain wherein the difference consists.

The quercitrin employed by the author was obtained from quercitron bark, and was found to have the properties and composition assigned to it by Liebermann and Hamburger. The rutin was derived from buckwheat leaves, and though it had been in the author's collection for many years had undergone no perceptible change.

A comparative examination of the two substances led to the conclusion that they are indeed extremely similar, but that they differ essentially as regards some of their properties; they also differ in composition.

Rutin yields with acids the same products of decomposition as quercetrin, viz., quercetin and isodulcite, but not in the same relative proportion; it gives less quercetin and more isodulcite. The analyses of rutin agree with the formula $C_{42}H_{50}O_{25}$, that of quercetrin being $C_{36}H_{38}O_{20}$. The process of decomposition with acids would be represented by the equation—

$$C_{42}O_{50}H_{25} + 4H_2O = C_{24}H_{16}O_{11} + 3C_6H_{14}O_6.$$

Hence it would appear that rutin is derived from 1 mol. of quercetin and 3 mols. of isodulcite, and quercitrin from only 2 mols. of the latter and 1 mol. of the former.

10. "*The Composition of Bird-lime.*" By E. Divers, M.D., F.R.S., and M. Kawakita, M.E., F.C.S.

Bird-lime from *Ilex aquifolium* was investigated a few years ago by J. Personne, who found in it, besides vegetable *débris* and water, calcium oxalate, caoutchouc, and ethereal salts of a solid crystalline alcohol, $C_{25}H_{44}O$, m.p. 175°, with undetermined fatty acids. The authors had partly examined Japanese bird-lime before Personne published his results, and were induced to continue their work afterwards by finding that their observations, to some extent, differed from and went beyond his. Indeed their work renders it probable that Japanese bird-lime, prepared as it is, not from *I. aquifolium*, but from *I. integra*, is different in some respects in composition from European bird-lime.

They find the fatty acids of the ethereal salts to be *palmitic acid*, and, in very small quantity, a semi-solid acid, the calcium salt of which is soluble in ether and in alcohol. They have obtained two very similar alcohols by hydrolysis, one differing only slightly from Personne's *ilicic alcohol*, which they have named *ilicylic alcohol*, and have found from closely concordant analyses to have the composition $C_{22}H_{38}O$; and another, which they have named *mochylic alcohol*, from *mochi*, the Japanese word for (bird-)lime, or glutinous matter, and which agrees closely in composition with the formula $C_{26}H_{46}O$. The melting-point of this alcohol is 234° C., and that of ilicylic alcohol 172°. The two alcohols are separated from each other and from a resinoid body, $C_{26}H_{44}O$, by a tedious process of fractional dissolution with spirit of varying strengths. The resinoid body is readily soluble in spirit as weak as 80 per cent, mochylic alcohol in that of 95 per cent or stronger, and ilicylic alcohol in that of 85 to 90 per cent or stronger. The resinoid body (m.p. 110°) volatilises above 360°, apparently but little changed; ilicylic and mochylic alcohols, without change in a vacuum, at about their respective melting-points. Heated with palmitic acid, the two alcohols are converted into compounds just like purified bird-lime. Caoutchouc is also present in Japanese bird-lime to the extent of about 6 per cent; but only minute quantities of oxalates. By destructive distillation bird-lime yields much palmitic acid and a thick, oily, hydrocarbon, $C_{26}H_{44}$, besides fluorescent and more carbonaceous hydrocarbons, very little gas, and very little carbonised residue. The authors consider bird-lime to be closely allied to the *waxes* in chemical constitution.

At the next meeting, on February 16th, there will be a ballot for the election of Fellows, and the following papers will be read:—

"An Analysis of Wackenroder's Solution and a Explanation of the Formation of its Proximate Constituents." By Prof. H. Debus, F.R.S.

"Potilizin's Law of Mutual Displacement of Bromine and Chlorine." By Prof. Thorpe and J. W. Rodger.

"The Action of Phosphorus Pentachloride on Salicyl Aldedyde." By C. M. Stuart.

"Some Reactions of Nitrogen Chloro-phosphuret." By Ward Couldridge.

NOTICES OF BOOKS.

Olfactics and the Physical Senses. By Charles Henry Piesse, M.R.C.S., F.C.S., &c. London: Piesse and Lubin.

We have here a most remarkable work, worth reading not merely by men of Science, but by all intelligent persons, who may here pick up not a few valuable lessons. Amidst his argument the author introduces, in the most natural and easy manner, flashes of satire which we hope may scorch deeply in the quarters at which they are evidently aimed.

His starting-point is a denunciation of the manner in which our senses are in modern life blunted by misuse and neglect. As regards sight, he admits with satisfaction that some attention has been drawn to the abuse of sight. The labours of Mr. Brudenell Carter, F.R.C.S., unpalatable as the results have been to the School Board, are of immense value. Says our author:—"We have to put up with government by fads. That the look-out on board every ship that sails could not see a yard beyond his nose is nothing. The one point, and the only point, to some is—Did he pass the Sixth Standard? The same with our artillery men, our soldiers, and volunteers; to see clearly a mile off is nothing,—Did they pass the Sixth Standard?"

In the chapter on Touch we read:—"How useful is it to be able to pick a good silk or a good cloth, and to know that we are not being cheated by disciples of those great teachers who inform us that adulteration is another form of competition." So it doubtless is; but is this any justification?

Under "Taste" we find a very just remark:—"Probably our travelling fellow-countrymen owe their attacks of fever more to drinking water contaminated by sewage-matter than to the malarious influences which pervade certain districts of Southern Europe." This is highly probable.

The author justly condemns the table waters now imported from the Continent, from the very fact of their being vaunted as possessing medicinal properties. "We do not require drugs as diet."

In the sixth chapter Mr. Piesse comes to his main subject, Smell, assuredly the most neglected of the senses. He suggests the possibility that a large number of boilers contain dead cockroaches, "some of which probably have been daily boiled for years." We regret that the author should in this passage have used the misleading term "black beetles" for an insect which is neither a beetle nor black.

In the seventh chapter we find quoted the little-known classification of odours proposed by Linnæus. The classes are "aromatic (laurel leaves, or, more correctly, bay leaves), fragrant (jasmine), ambrosial (musk), alliaceous (garlic), fœtid (stinking goose-foot), repulsive (Solanaceæ) and nauseous odours," the last class doubtless including decomposing animal matters. Cases are given showing the tenacity with which scent-impressions are retained in the mind. We may forget the colour or the shape of some object; we may forget the peculiar tone of a human or animal voice; but a scent perceived half a century ago is at once identified when again met with.

In the paragraphs treating of the acuteness of the sense of smell in man it is stated that "less than the two-billionth part of a grain of camphor has been distinctly odorous." There is no mention of the precise experiments of Fischer and Penzoldt, in which 1-460,000,000th of a m.grm. of mercaptan was recognised.

The instances of the acuteness of scent of bloodhounds almost vanish when compared with that of certain male moths, such as *Saturnia carpini*. If a female of this species has just emerged from the chrysalis, and is placed in a closed box, males of the same species will come from distances of near a mile, though rising grounds and buildings intervene, and have even been known to find their way down the chimney to the abode of the fair prisoner.

A curious fact mentioned is that, in the opinion of hunting men, hounds are less keen scented than they were in the good old times, and that the fox more often baffles his pursuers. This fact, if fact it be, is easily explained on the principle of "natural selection." The fox which smelt most strongly would be most likely to be captured; the one less odoriferous would have a greater chance of escaping, and consequently of leaving descendants who would probably inherit his feebly odoriferous character. Hence, in a country where fox-hunting is a pursuit of long standing, the breed of foxes will be modified by degrees until they scarcely leave any smell at all.

By what process of "unnatural selection" have arisen those women in the South of Europe who dislike, and are ready to faint at, the scent of a rose, and yet find nothing offensive in dirt and putrefaction?

In the concluding chapter, on the "Harmony of the Senses," Mr. Piesse indulges in speculations on analogies between scent and sound. His father, the late Septimus Piesse, believed the seven primary odours to be camphor, lemon, jasmine, rose, almond, clove, and santal. We should rather feel disposed to search for analogies between odours and colours, associated as we find them in Nature.

We hope that Mr. Piesse's work will find readers both many and attentive. Both from the theoretical and the practical side it must prove suggestive.

CORRESPONDENCE.

INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—Whatever alterations for the entrance to the Institute the new Council may adopt, it is to be hoped that a certificate of general knowledge as recognised for the preliminary requirements by the legal and medical profession may be a condition *sine qua non* for admission.

"Primum esse, tum philosophari."

—I am, &c.,

F.I.C.

February 6, 1888.

MR. ALLEN'S METHOD FOR THE DETECTION OF HOP SUBSTITUTES IN BEER.

To the Editor of the Chemical News.

Sir,—It appears to me that Mr. Arnold is not acquainted with all that has been said on the subject upon which he writes. In the days of high pressure it is absolutely necessary for one to have a thorough knowledge of the work he ventures to criticise, as in this instance it would have prevented Mr. Arnold reiterating in your columns

what has already been done. In October last I read a short paper before the Society of Public Analysts upon the "Detection of Hop Substitutes in Beer," and in the discussion which followed several of the members of the Society confirmed my remarks, as well as Mr. Allen, who, in a frank manner, candidly acknowledged that, since his paper was published, he was convinced that the process as advocated by himself was not all that could be desired, at the same time stating that he was glad of having the opportunity of so doing. Under the circumstances Mr. Arnold is rather behind in his criticisms contained in your issue of the 27th ult., otherwise I should not have ventured to trespass upon your valuable space.—I am, &c.,

WILLIAM JOHNSTONE.

City Central Laboratory,
13, Fish Street Hill, Jan. 30, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 3, January 16, 1888.

New Researches on the Phenomena produced by a very powerful Toxic Agent thrown off from the Lungs of Men and other Mammals along with the Expired Air.—MM. Brown-Séquard and D'Arsonval.—The authors have demonstrated that the poison is not a micro-organism, but a chemical compound of an alkaline nature, allied to the ptomaines and the leucomaines.

The Decreasing Solubility of Sulphates.—A. Etard.—It is generally admitted that the sulphates are more soluble in heat than in the cold, with the exception of the sodium, lithium, calcium, and thorium salts. The author finds that the decrease of solubility for rising temperatures, far from being exceptional, is the rule for the sulphates.

Presence of a Glycol in the Products of the Alcoholic Fermentation of Sugar.—MM. Henninger and Sanson.—M. Henninger announced, in 1882, the presence of isobutyl-glycol in a red wine from Bordeaux. It is also found in the liquids obtained from sugar, fermented by beer-yeast.

On the Methyl Acetyl-cyanacetate.—A. Haller and A. Held.—This paper does not admit of useful abstraction.

The Presence of Volatile Bases in Blood and in the Air Expired.—R. Wurtz.—The base obtained gives a precipitate with Bouchardat's reagent, and with the double mercury and potassium iodate. It forms a soluble chloroplatinate and chloraurate. The quantity of material at the author's disposal did not admit of its analysis.

Zeitschrift fur Analytische Chemie. Vol. xxvi., Part 2.

Iodometric Studies.—G. Topf.—This memoir, the first or general portion of which, here inserted, extends over 80 pages, admits neither of satisfactory abstraction nor of reproduction in full.

The Definition of Normal Solutions for Volumetry.—C. Marx.—As every standard solution must contain a certain absolute weight of the effective substance the author takes, as the basis of his system, the relation of the reagent to one grm. of hydrogen.

The Use of Solidified Bromine for opening up Sulphuretted Minerals and Furnace-Products.—Dr. Albano Brand.—Solidified bromine consists of kieselguhr saturated with bromine and thus rendered very convenient for use. The author places the pulverised mineral in a boat, which is then inserted in a tube. After it follow portions of the solidified bromine, and the tube is then closed at the entrance end. The other end opens into a couple of U-tubes. The tube is gradually heated, beginning at the closed end, and as soon as the air is expelled, the boat itself is heated.

Gas Apparatus for Gasometric Analysis.—A. Ehrenberg.—This paper cannot be reproduced without the four accompanying engravings.

Efflux-Point for Burettes.—W. Leybold.—The author's arrangement cannot be explained verbally.

Practical Methods for Photographing the Spectrum.—J. M. Eder.—These methods are not described.

Determining Melting- and Solidification-Points.—M. Loviton.—From the *Bulletin de la Soc. Chimique*, to which reference is made for details.

Two Arrangements for Reading off the Volume of Gases.—H. N. Morse.—From the *American Chemical Journal.*

The Extraction of Liquids with Volatile Solvents.—A. Eiloart.—From the CHEMICAL NEWS.

Safety Apparatus for Extraction.—C. B. Gibson.—From the *Analyst.*

Apparatus for Fractional Distillation under Reduced Pressure.—Modifications of E. J. Bevan's apparatus, proposed by Konowalow, Gorboff, and Kessler.

A Dephlegmatisation-Capital for Fractionated Distillation.—F. Anderlini.—The apparatus here figured does not admit of intelligible description.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Acid-Resisting-Cement.—Can any reader say where an acid-resisting cement can be procured, which is used for cementing Doulton's acid-proof earthenware pipes in a laboratory?—ÆOLUS.

MEETINGS FOR THE WEEK.

MONDAY, 13th.—Medical, 8.30.
— Society of Arts, 8. "Yeast, its Morphology and Culture," by A. Gordon Salamon, F.C.S.
TUESDAY, 14th.—Royal Medical and Chirurgical, 8·30.
— Institution of Civil Engineers, 8.
— Photographic, 8. (Anniversary).
— Royal Institution, 3. "Before and After Darwin," by George John Romanes, F.R.S.
— Socety of Arts, 8. "The Principles of Design, as applied to Bookbinding," by Henry B. Wheatley.
WEDNESDAY, 15th.—Meteorological, 7.
— Society of Arts, 8. "Type-writers aad Type-writing," by John Harrison.
THURSDAY, 16th.—Royal, 4.30.
— Society of Arts, 8. "Etching and Mezzo-Tint Engraving," by Prof. Hubert Herkomer, A.R.A.
— Royal Institution 3. "Early Secular Choral Music," by Prof. Hubert H. Parry, M.A.
— Chemical, 8. "On the Analysis of Wackenroder's Solution, and an Explanation of the Formation of its Proximate Constituents," by Prof. H. Debus, F.R.S. "Polilizire's Law of Mutual Displacement of Bromine and Chlorine," by Prof. Thorpe and G. W. Rodger. "The Action of Phosphorus Pentachloride on Salicylaldehyd," by C. M. Stuart. "Some Reactions of Nitrogen Chlorophosphuret," by Ward Coleridge.
— Parkes Museum, 5. "Plagues, Ancient and Modern," by J. F. Payne, B.A., M.D., F.R.C.P.
FRIDAY, 17th.—Geological, 1. (Anniversary).
— Royal Institution, 9. "Some Developments of English Pottery During the last Fifty Years," by Sir Henry Doulton.
SATURDAY, 18th.—Royal Institution, 3. "Experimental Optics," by the Right Hon. Lord Rayleigh.

TO CORRESPONDENTS.

Clara Wildersbruck.—The question should be addressed to a medical paper.

THE CHEMICAL NEWS.

Vol. LVII. No. 1473.

ON THE

BEHAVIOUR OF THE SOLUBLE PHOSPHORIC ACID OF SUPERPHOSPHATES MADE FROM BELGIAN PHOSPHATES TO THE SOLVENT USED, AFTER LONG STORAGE.*

By A. BEYER, Ph.D.

In the course of a series of comparative experiments which I undertook for the purpose of determining how far the Petermann and the Wagner methods for the estimation of phosphoric acid soluble in citrate differ, when different substances are operated upon, I noticed that, in superphosphates which had been long stored, not only had a decided reversion in the phosphoric acid soluble in water taken place, but also in that obtained by the use of the solvent recommended by Wagner. This, however, was less noticeable with the form of soluble phosphoric acid found by the Petermann solvent.

As this peculiarity might easily give rise to unpleasant discrepancies and losses (affecting the consumer as well as the manufacturer) I have endeavoured by a series of experiments to determine how far the above observation is founded upon fact.

The following tables contain :—

1. A number of analytical data from experiments made with raw phosphates containing 2½ to 3 per cent oxide of iron and alumina, and intended merely to furnish some comparative results concerning the two methods.
2. A series of experiments made with phosphates similar as regards the oxide of iron and alumina to those used in 1, but mixed with different proportions of acid and tested periodically.
3. A series of experiments, *a*, *b*, and *c*, in which raw phosphates of very high percentage of oxide of iron and alumina were used; *a* and *b* with the use of different proportions of acid and tested only once; *c* with the use of different proportions of acid and tested periodically.

In regard to the methods of analysis, I may remark that I kept strictly to the directions given by Petermann† and Wagner‡. The only deviation from the original methods which I allowed myself, was in the phosphoric acid determinations for the Petermann method in those superphosphates containing the very high percentage of oxide of iron and alumina, in which cases, instead of precipitating direct with magnesia mixture, I separated the phosphoric acid in the first place by means of ammonium molybdate, but the solution in which I precipitated was prepared absolutely according to the directions. Although in the case of the superphosphates containing the smaller proportion of oxide of iron and alumina closely agreeing results were obtained by direct precipitation in the ammoniacal citrate solution, it was not so with those rich in oxide of iron and alumina, the results of which differed somewhat widely. I therefore preferred to make use of the preliminary precipitation with ammonium molybdate.

I. Oxide of Iron and Alumina in the Raw Phosphate, 2·5 to 3 per cent.

Description of superphosphate.	Soluble in water.	Soluble by Wagner method.	Soluble by Petermann method.	Total phosphoric acid.
P.c. sol. in water.	Per cent.	Per cent.	Per cent.	Per cent.
14	14·15	15·04	15·28	15·42
12	12·50	12·80	13·28	13·32
10	10·25	10·88	11·90	12·16

II. Oxide of Iron and Alumina in the Raw Phosphate, 2·5 to 3 per cent.

Proportion of raw phosphate to acid of 50° B.	Date when determination was made.	Phosphoric acid soluble in water.	Soluble by Wagner method.	Soluble by Petermann method.	Total phosphoric acid.
		P.c.	P.c.	P.c.	P.c.
100 : 85	23 10 86	9·82	11·69	12·38	12·80
	1 12 86	8·58	9·67	11·93	,,
	9 12 86	8·25	9·38	12·01	,,
	5 1 87	8·48	9·63	12·00	,,
100 : 90	23 11 86	10·10	11·69	12·51	12·54
	1 12 86	8·81	9·75	11·93	,,
	9 12 86	8·46	9·21	11·99	,,
	5 1 87	8·45	9·36	11·77	,,
100 : 95	23 11 86	10·38	11·92	12·05	12·12
	1 12 86	8·92	9·79	11·75	,,
	9 12 86	8·20	9·25	11·75	,,
	5 1 87	8·30	9·20	11·58	,,
100 : 100	23 11 86	10·27	11·72	11·94	11·99
	1 12 86	9·34	10·53	11·87	,,
	9 12 86	9·50	9·76	11·83	,,
	5 1 87	9·44	9·76	11·67	,,

III.*a*. Oxide of Iron and Alumina in the Raw Phosphate, 9·7 per cent.

Proportion of raw phosphate to acid of 50° B.	Phosphoric acid soluble in water.	Soluble by Wagner method.	Soluble by Petermann method.	Total phosphoric acid.
	Per cent.	Per cent.	Per cent.	Per cent.
100 : 90	3·65	6·91	9·44	11·52
100 : 95	4·44	7·74	9·68	11·11
100 : 100	5·17	8·06	9·84	10·82

III.*b*. Oxide of Iron and Alumina in the Raw Phosphate, 8·27 per cent.

100 : 80	6·34	—	—	14·98
100 : 85	6·81	8·96	11·21	14·65
100 : 90	8·38	8·96	11·52	14·16
100 : 95	8·65	9·50	11·76	13·76
100 : 100	8·75	9·56	12·40	13·46

III.*c*. Oxide of Iron and Alumina in the Raw Phosphate, 8·27 per cent.

Proportion of raw phosphate to acid of 52° B.	Date when analysis was made.	Phosphoric acid soluble in water.	Soluble by Wagner method.	Soluble by Petermann method.	Total phosphoric acid.
		P.c.	P.c.	P.c.	P.c.
100 : 90	13 1 87	3·13	5·81	10·00	10·62
	11 2 87	2·48	4·76	9·88	,,
	12 3 87	2·64	4·83	10·03	,,
100 : 95	13 1 87	3·58	6·09	10·31	10·57
	11 2 87	2·27	4·41	10·23	,,
	12 3 87	1·41	4·45	10·23	,,
100 : 100	13 1 87	3·83	5·63	10·04	10·05
	11 2 87	2·72	4·76	10·01	,,
	12 3 87	1·85	4·13	10·14	,,

These experiments lead to the following conclusions :—

1. The Petermann method, used with superphosphates, gives higher results, under all circumstances, than the Wagner method.
2. With superphosphates poor in oxide of iron and alumina (see Tables I. and II.) the difference between the two methods, within a short time of dissolving, is not so very great, but in eight days the phosphoric acid found by the Wagner method (concurrently with the phosphoric acid soluble in water) goes back to such an extent that of 100 parts previously soluble by the Wagner method about 17 parts become insoluble. By the use of larger proportions of acid the reversion during the first eight days is lessened, but even in that case after the lapse of fourteen days it amounts to as much; from that

* From the *Repertorium der Analytischen Chemie*, vii., 22. Translated and contributed by H. H. B. Shepherd.

† *Bulletin de la Station agricole de l'état à Gimbloux*, No. 33.

‡ Fresenius, "Quant. Analyse," 6 Aufl., 2, 703.

time forward, however, no further change takes place, either in the phosphoric acid soluble in water, or in that found by the Wagner method, even after further storing for from four to six weeks.

The determinations by the Petermann method in these superphosphates, show only a comparatively small decrease in the soluble phosphoric acid capable of being found by the method, and these differences are probably due partly to sources of error in the analyses themselves.

3. With superphosphates rich in oxide of iron and alumina one finds, shortly after dissolving, very considerable differences between the two methods (Tables III. *a*, *b*, and *c*), and on storing, these differences always increase, but here again the results by the Petermann method remain almost absolutely constant, whereas in the phosphoric acid soluble in water, as well as in that found by the Wagner method, considerable reversion takes place.

Note by Translator.—For a full description of the Wagner method referred to see, translation of Professor Wagner's original paper contributed to the *Chemiker Zeitung* in the Chemical News, vol. liii., p. 133.

ON AUSTRALIAN GOLD AND NATIVE METALLIC ANTIMONY.

By R. W. EMERSON MACIVOR, F.I.C., F.R.G.S., F.C.S. &c.

Gold.

Perhaps the most extraordinary form in which gold has yet been found in quantity is that in which it occurs in a matrix of serpentine, at Gumdagai, in New South Wales. It there exists as fine flakes distributed irregularly through the rock. The first samples of stone submitted to me for assay had the appearance of having had the metal painted on thin surfaces by hand. This exceeding thinness of the gold has, however, been characteristic of all the ore—about 200 tons or so—taken from the mine during the past few years. The total gold per ton has ranged from a few pennyweights to several ounces, but, owing to the extreme firmness of the metal and the nature of the matrix, much difficulty is experienced in catching all the gold by the ordinary amalgamation process. There appears to be an unlimited supply of stone in the mine, and with suitable machinery I have no doubt but that the property would ultimately yield large profits, particularly as it also contains abundance of excellent asbestos, for which there is a good local demand. I have found some specimens of the latter mineral to contain gold in appreciable quantity.

Antimony.

While I was resident in Melbourne my friend Mr. J. Cosmo Newbury, C.M.G., enabled me to obtain some good specimens of native antimony, and of calcite and quartz containing the metal, which had been found in some part of northern Queensland, but, owing to the reticence of the finders, I could not at the time obtain information as to the exact locality from which they had been brought. Since then I have heard nothing further on the subject, nor have I seen any reference made to the discovery in the able geological and mineralogical reports of Mr. Jack, F.G.S., to the Government of Queensland. That the metal occurred in something like quantity may be judged from the fact that several hundred tons were brought to Melbourne, and there run into block at the antimony smelting-works on the south banks of the Yarra.

All the specimens had the appearance of being water-worn, and in none of them could I detect either stibnite or sulphate of barium. Several of them—one weighing about 1200 grms.—consisted of the metal only, and on being broken presented the well-known laminated fracture of the metal of commerce. Others chiefly consisted of carbonate of lime, with the metal also in the laminated state, scattered unevenly throughout its mass. One specimen consisted of quartz, with two small veins of the metal running from end to end, and a few small patches between.

The antimony was singularly pure, containing mere traces of foreign substances.

St. George's Club, Hanover Square, W.

NOTE ON EXTENSIVE DISCOVERIES OF ALUM-STONE (ALUNITE) AND SULPHUR IN NEW SOUTH WALES.

By R. W. EMERSON MACIVOR, F.I.C., F.R.G.S., F.C.S., &c.

My late colleague, Mr. S. Herbert Cox, F.G.S., the eminent mining authority of Australia, while exploring a property in the County of Gloucester, N.S.W., which was supposed to be auriferous, came upon an apparently limitless extent of white semi-translucent rock, which had previously been believed to be quartz, but which on examination proved to be the mineral known as alunite, and consisting of the elements of potash alum with an excess of hydrate of aluminium. On heating the stone to expel the constitutional water of the aluminic hydrate, and lixiviating the residue, a solution is obtained which on evaporation gives crystals of alum perfectly free from the faintest indication of iron. The rock yields about its own weight of alum.

One or two samples of the mineral which Mr. Cox showed me had a very slight pinkish hue, probably owing to the presence of a trace of manganese, but the great mass of the stone is perfectly white even after wasting.

Extensive works have been erected, or are in course of erection, to manufacture alum for local consumption and export. It is also intended to ship the stone to Europe, and the facilities for doing this are such that any quantity can be put down in London at less than forty shillings per ton.

Since my arrival in England I have heard from Mr. Cox that large deposits of sulphur have also been found on the property. This will render the colonial vitriol-makers independent of Sicily, from whence they have hitherto been getting their supplies of the substance.

METHODS FOR THE DETERMINATION OF NITROGEN.*

The Absolute or Cupric Oxide Method.

The apparatus and reagents needed are as follows:—

Apparatus.

Combustion tube of best hard Bohemian glass, about 26 inches long and one-half inch internal diameter.

Azotometer of at least 100 cubic centimetres capacity, accurately calibrated.

Sprengel mercury air pump.

Small paper scoop, easily made from stiff writing-paper.

Reagents.

Cupric Oxide (coarse).—Wire form; to be ignited and cooled before using.

Fine Cupric Oxide.—Prepared by pounding ordinary cupric oxide in mortar.

Metallic Copper.—Granulated copper or fine copper gauze reduced and cooled in stream of hydrogen.

Sodium Bicarbonate.—Free from organic matter.

* Official Methods of Analysis of the Association of Official Agricultural Chemists for 1887-88. U.S. Department of Agriculture, Division of Chemistry.

Caustic Potash Solution.—Dissolve commercial stick potash in less than its weight of water, so that crystals are deposited on cooling. When absorption of carbonic acid ceases to be prompt solution must be discarded.

Loading Tube.

Of ordinary commercial fertilisers take 1 to 2 grms. for analysis. In the case of highly nitrogenous substances the amount to be taken must be regulated by the amount of nitrogen estimated to be present. Fill tube as follows:—(1) About 2 inches of coarse cupric oxide. (2) Place on the small paper scoop enough of the fine cupric oxide to fill, after having been mixed with the substance to be analysed, about 4 inches of the tube; pour on this the substance, rinsing watch-glass with a little of the fine oxide and mix thoroughly with spatula; pour into tube, rinsing the scoop with a little fine oxide. (3) About 12 inches of coarse cupric oxide. (4) About 3 inches of metallic copper. (5) About 2½ inches of coarse cupric oxide (anterior layer). (6) Small plug of asbestos. (7) Eight-tenths to 1 grm. of sodium bicarbonate. (8) Large, loose plug of asbestos; place tube in furnace, leaving about 1 inch of it projecting; connect with pump by rubber stopper smeared with glycerin, taking care to make connection perfectly tight.

Operation.

Exhaust air from tube by means of pump. When a vacuum has been obtained, allow flow of mercury to continue, light gas under that part of tube containing metallic copper, anterior layer of cupric oxide (see 5th above) and bicarbonate of soda. As soon as vacuum is destroyed and apparatus filled with carbonic acid gas, shut off the flow of mercury and at once introduce the delivery tube of the pump into the receiving arm of the azotometer and just below the surface of the mercury seal of the azotometer, so that the escaping bubbles will pass into the air and not into the azotometer, thus avoiding the useless saturation of the caustic potash solution.

When the flow of carbonic acid has very nearly or completely ceased, pass the delivery tube down into the receiving arm, so that the bubbles will escape into the azotometer. Light the jets under the 12-inch layer of oxide, heat gently for a few moments to drive out any moisture that may be present, and bring to red heat. Heat gradually mixture of substance and oxide, lighting one jet at a time. Avoid too rapid evolution of bubbles, which should be allowed to escape at rate of about one per second or a little faster.

When the jets under mixture have all been turned on, light jets under layer of oxide at end of tube. When evolution of gas has ceased turn out all the lights except those under the metallic copper and anterior layer of oxide, and allow to cool for a few moments. Exhaust with pump and remove azotometer before flow of mercury is stopped. Break connection of tube with pump, stop flow of mercury and extinguish lights. Allow azotometer to stand for at least an hour or cool with stream of water until permanent volume and temperature are reached.

Adjust accurately the level of the KOH solution in bulb to that in azotometer, note volume of gas, temperature, and height of barometer; make calculations as usual. The labour of calculation may be much diminished by the use of the tables prepared by Messrs. Battle and Dancy, of the North Carolina Experiment Station (Raleigh, N.C.).

The above details are, with some modifications, those given in the report of the Connecticut Station for 1879 (p. 124), which may be consulted for details of apparatus, should such details be desired.

Determination by the Method of Kjeldahl.

Reagents and Apparatus.

(1) Hydrochloric acid whose absolute strength has been determined, (*a*) by precipitating with silver nitrate and weighing the silver chloride, (*b*) by sodium carbonate, as described in Fresenius's "Quantitative Analysis," second American edition, page 680, and (*c*) by determining the amount neutralised by the distillate from a weighed quantity of pure ammonium chloride boiled with an excess of sodium hydrate.

(2) Standard ammonia whose strength, relative to the acid, has been accurately determined

(3) "C. P" sulphuric acid, specific gravity 1·83, free from nitrates and also from ammonium sulphate, which is sometimes added in the process of manufacture to destroy oxides of nitrogen.

(4) Mercuric oxide, HgO, prepared in the wet way. That prepared from mercury nitrate cannot safely be used.

(5) Potassium permanganate tolerably finely pulverised.

(6) Granulated zinc.

(7) A solution of 40 grms. of commercial potassium sulphide in one litre of water.

(8) A saturated solution of sodium hydrate free from nitrates, which are sometimes added in the process of manufacture to destroy organic matter and improve the colour of the product. That of the Greenbank Alkali Company is of good quality.

(9) Solution of cochineal prepared according to Fresenius's "Quantitative Analysis," second American edition, page 679.

(10) Burettes should be calibrated in all cases by the user.

(11) Digestion flasks of hard, moderately thick, well-annealed glass. These flasks are about 9 inches long, with a round, pear-shaped bottom, having a maximum diameter of 2½ inches, and tapering out gradually in a long neck, which is three-fourths of an inch in diameter at the narrowest part, and flared a little at the edge. The total capacity is 225 to 250 c.c.

(12) Distillation flasks of ordinary shape, 550 c.c. capacity, and fitted with a rubber stopper and a bulb tube above to prevent the possibility of sodium hydrate being carried over mechanically during distillation. This is adjusted to the tube of the condenser by a rubber tube.

(13) A condenser. Several forms have been described, no one of which is equally convenient for all laboratories. The essential thing is that the tube which carries the steam to be condensed shall be of block tin. All kinds of glass are decomposed by steam and ammonia vapour, and will give up alkali enough to impair accuracy. (See Kreussler and Henzold, *Ber. Berichte*, xvii., 34). The condenser in use in the laboratory of the Connecticut Experiment Station, devised by Professor Johnson, consists of a copper tank supported by a wooden frame, so that its bottom is 11 inches above the work-bench on which it stands. This tank is 16 inches high, 32 inches long, and 3 inches wide from front to back, widening above to 6 inches. It is provided with a water-supply tube which goes to the bottom and a larger overflow pipe above. The block tin condensing tubes, whose external diameter is ⅝ of an inch, seven in number, enter the tank through holes in the front side of it near the top, above the level of the overflow, and pass down perpendicularly through the tank and out through rubber stoppers tightly fitted into holes in the bottom. They project about 1½ inches below the bottom of the tank, and are connected by short rubber tubes with glass bulb tubes of the usual shape, which dip into glass precipitating beakers. These beakers are 6½ inches high, 3 inches in diameter below, somewhat narrower above, and of about 500 c.c. capacity. The titration can be made directly in them. The seven distillation flasks are supported on a sheet-iron shelf attached to the wooden frame that supports the tank in front of the latter. Where each flask is to stand a circular hole is cut, with three projecting lips, which support the wire gauze under the flask, and three other lips which hold the flask in place and prevent its moving laterally out of place while distillation is going on. Below this sheet-iron shelf is a metal tube carrying seven Bunsen burners, each with a stop cock like those of a gas combustion furnace. These burners are of larger diameter at the top, which prevents smoking when covered with fine gauze to prevent the flame from striking back.

(14) The stand for holding the digestion flasks consists of a pan of sheet-iron, 29 inches long by 8 inches wide, on the front of which is fastened a shelf of sheet-iron as long as the pan, 5 inches wide and 4 inches high. In this are cut six holes 1⅜ inches in diameter. At the back of the pan is a stout wire running lengthwise of the stand, 8 inches high, with a bend or depression opposite each hole in the shelf. The digestion flask rests with its lower part over a hole in the shelf and its neck in one of the depressions in the wire frame, which holds it securely in position. Heat is supplied by low Bunsen burners below the shelf. With a little care the naked flame can be applied directly to the flask without danger.

The Determination.

One grm. of the substance to be analysed is brought into a digestion flask with approximately 0·7 grm. of mercuric oxide and 20 c.c. of sulphuric acid. The flask is placed on the frame above described in an inclined position, and heated below the boiling-point of the acid for from five to fifteen minutes, or until frothing has ceased. The heat is then raised till the acid boils briskly. No further attention is required till the contents of the flask have become a clear liquid, which is colourless, or at least has only a very pale straw colour. The flask is then removed from the frame, held upright, and, while still hot, potassium permanganate is dropped in carefully, and in small quantity at a time, till after shaking the liquid remains of a green or purple colour. After cooling, the contents of the flask are transferred to the distilling flask with water, and to this 25 c.c. of potassium sulphide solution are added, 50 c.c. of the soda solution, or sufficient to make the reaction strongly alkaline, and a few pieces of granulated zinc. The flask is at once connected with the condenser, and the contents of the flask are distilled till all ammonia has passed over into the standard acid contained in the precipitating flask previously described, and the concentrated solution can no longer be safely boiled. This operation usually requires from twenty to forty minutes. The distillate is then titrated with standard ammonia.

The use of mercuric oxide in this operation greatly shortens the time necessary for digestion, which is rarely over an hour and a half in the case of substances most difficult to oxidise, and is more commonly less than an hour. In most cases the use of potassium permanganate is quite unnecessary, but it is believed that in exceptional cases it is required for complete oxidation, and in view of the uncertainty it is always used. Potassium sulphide removes all mercury from solution, and so prevents the formation of mercuro-ammonium compounds which are not completely decomposed by soda solution. The addition of zinc gives rise to an evolution of hydrogen, and prevents violent bumping. Previous to use the reagents should be tested by a blank experiment with sugar, which will partially reduce any nitrates that are present which might otherwise escape notice.

The following modification must be used for the determination of nitrogen in substances which contain nitrates when it is desired to use this method.

*Determination of Nitrogen, including the Nitrogen of Nitrates, by a Modified Method of Kjeldahl.**

Bring from 0·7 to 1·4 grms. of the substance to be analysed into a Kjeldahl digesting flask, add to this 36 c.c. of sulphuric acid containing 2 grms. of salicylic acid, and shake thoroughly. Then add *gradually* 3 grms. of zinc-dust, shaking the contents of the flask at the same time. Finally, add 2 or 3 drops of platinic chloride solution, and place the flask on the stand for holding the digestion flasks, where it is heated over a low flame until all danger from frothing has passed. The heat is then raised until the acid boils briskly, and the boiling continued until white fumes no longer pour out of the flask. This requires about five or ten minutes. Add now approximately 0·7 grm. mercuric oxide, and continue the boiling until the liquid in the flask is colourless or nearly so. (In case the contents of the flask are likely to become solid before this point is reached add 10 c.c. more of sulphuric acid.) Complete the oxidation with a little permanganate of potash in the usual way, and proceed with the distillation as described in the method above.

* Described by Prof. M. A. Scovell.

Determination by the Ruffle Method.

Preparation of Reagents.

(1) *A standard solution of sulphuric acid*, half normal, or 19·968 grms. SO_3 per litre.

(2) *A standard solution of potassium hydrate*, half normal, or 27·991 grms. KOH per litre.

(3) *An alcoholic solution of cochineal.*

(4) *Hyposulphite mixture.*—Prepared by mixing equal parts by weight of soda-lime and finely-powdered crystallised sodium hyposulphite.

(5) *Sugar and sulphur mixture.*—This is prepared by mixing equal parts by weight of finely-powdered granulated sugar and flowers of sulphur.

(6) *Ordinary granulated soda-lime.*

Apparatus.

(1) *Combustion tubes* of hard Bohemian glass, 20 inches long and ½ inch internal diameter, drawn to a point.

(2) *Three-bulb, 6-inch U-tubes*, with glass stopcock.

(3) *Aspirator.*

Preparation.

(1) Clean and fill the U-tube with 10 c.c. of standard acid.

(2) Fit cork and glass connecting-tube. Fill the tube as follows:—(1) A loosely-fitting plug of asbestos, previously ignited, and then 1 to 1½ inches of the hyposulphite mixture. (2) The weighed portion of the substance to be analysed is intimately mixed with from 5 to 10 grms. of the sugar and sulphur mixture. (3) Pour on a piece of glazed paper, or porcelain mortar, a sufficient quantity of the hyposulphite mixture to fill about 10 inches of the tube; then add the substance to be analysed, as previously prepared; mix carefully and pour into the tube; shake down the contents of the tube; rinse off the paper or mortar with a small quantity of the hyposulphite mixture and pour into the tube; then fill up with soda-lime to within 2 inches of the end of the tube. (4) Place another plug of ignited asbestos at the end of the tube, and close with a cork. (5) Hold the tube in a horizontal position, and tap on the table until there is a gas channel all along the top of the tube. Make connection with the U-tube containing the acid, aspirate, and see that the apparatus is tight.

The combustion.—Place the prepared combustion-tube in the furnace, letting the open end project a little or so as not to burn the cork. Commence by heating the soda-lime portion until it is brought to a full red heat. Then turn up slowly jet after jet toward the outer end of the tube, so that the bubbles come off two or three a second. When the whole tube is red-hot and the evolution of the gas has ceased, and the liquid in the U-tube begins to recede towards the furnace, attach the aspirator to the other limb of the U-tube, break off the end of the tube, and draw a current of air through for a few minutes. Detach the U-tube and wash the contents into a beaker or porcelain basin, add a few drops of the cochineal solution, and titrate.

Determination by the Soda-Lime Method.

Select a tube of hard glass 14 to 16 inches long, draw one end of it to a fine point, and to the other end fit a cork, through which is passed a tube bent at right angles, the other end of which passes through a cork closing tightly one arm of a 6-inch three-bulbed U-tube with glass stopcock. Into the combustion-tube first slip a loosely-fitting plug of asbestos previously ignited, and then 1½ to

2 inches of soda-lime. Weigh out from 0·7 to 2·8 grms. of the substance to be analysed, and mix it on a piece of glazed paper or porcelain mortar with some finely pulverised soda-lime, and introduce the mixture into the combustion-tube. The paper or mortar is then rinsed out with a small quantity of soda-lime and poured into the tube. The tube is then filled up to within 1 to 2 inches of the open end with granulated soda-lime, then with a plug of ignited asbestos. A free passage is formed for the evolved gases by holding the tube in a horizontal position and tapping gently on the table. Introduce the prepared combustion-tube into the furnace, letting the open end project a little so as not to burn the cork, supporting the U-tube by a clamp. The tube is then gradually heated, commencing at the fore part, nearest the cork, and progressing slowly towards the tail. The combustion should be conducted so as to obtain a steady and uninterrupted flow of gas. When properly carried out the acid in the U-tube is never coloured. When the acid begins to recede attach the aspirator to the other limb of the U-tube and start it slowly, then break off the point of the combustion-tube and draw a current of air through the apparatus for a few minutes, in order to sweep all the ammonia into the acid,

Detach the U-tube and wash the contents into a beaker or porcelain basin, add a few drops of an alcoholic solution of cochineal, and titrate.

The standard acid and alkali to be the same as that used in the Ruffle method.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending January 31st, 1888.

By WILLIAM CROOKES, F.R.S.;

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To General A. De Courcy Scott, R.A.,
Water Examiner, Metropolis Water Act, 1871.

London, February 7th, 1888.

Sir,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from January 1st to January 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The whole of the 182 samples examined were clear, bright, and well filtered.

Throughout the month of January the condition of the water furnished to the Metropolis by the Companies taking their supply from the Thames and the Lea, continued to be unquestionably excellent. The quantity of organic matter present in the water, as determined by estimations alike of the oxygen required for its oxidation and of the amount of its constituent carbon, was found to be very small, and exceptionally small for the period of the year. The mean proportion of organic carbon present in the Thames-derived supply, or 0·158 part, and the maximum proportion in any one sample, or 0·188 part, in 100,000 parts of the water, are almost identical with the mean and maximum respectively of the preceding month. The colour-tint of the water, though too slight to be recognisable by ordinary observation, was found, when estimated by the colorimeter, to be on the average a little in excess of that noticeable in the preceding month. On several days of the month no estimations of colour-tint could be made, by reason of the prevailing fog rendering colour observations impossible.

We are, Sir,
Your obedient Servants,
William Crookes.
William Odling.
C. Meymott Tidy.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Annual General Meeting, February 11th, 1888.

Dr. J. H. Gladstone, F.R.S., Vice-President, in the Chair.

The Chairman read the Report of the Council for the past year, and expressed regret at the losses the Society had sustained by the deaths of Dr. Stewart (their late President), Prof. Kirchoff, Mr. Coutts Trotter, and Prof. Humpidge.

The Council regret that no increase of Members has taken place during the past year, and hope that the advantages offered by the Society may be more fully appreciated in future.

Obituary notices of Dr. B. Stewart, Mr. Coutts Trotter, and Prof. Humpidge were then read.

The Treasurer's Report shows that the financial condition of the Society is very satisfactory.

On the motion of Mr. Lant Carpenter, seconded by Mr. Inwards, the Reports were adopted.

The following gentlemen were elected Members of Council for the present year:—

President—Prof. A. W. Reinold, F.R.S.

Vice-Presidents—Dr. E. Atkinson; Prof. W. E. Ayrton, F.R.S.; Shelford Bidwell, F.R.S.; and Prof. H. McLeod, F.R.S.

Secretaries—Mr. Walter Baily, M.A., and Prof. J. Perry, F.R.S.

Treasurer—Prof. A. W. Rücker, F.R.S.

Demonstrator and Librarian—Mr. C. V. Boys.

Other Members of Council—Hon. R. Abercromby; R. H. M. Bosanquet, M.A.; W. H. Coffin; Conrad W. Cooke; Prof. F. Fuller, M.A.; W. N. Shaw, M.A.; A. Stroh; Prof. S. P. Thompson, D.Sc.; H. Tomlinson, B.A.; G. M. Whipple, B.Sc.

On taking the chair the new President expressed his sincere thanks for the great honour the Society had conferred upon him.

Prof. Fuller proposed a vote of thanks to the Lords of Committee of Council on Education for the use of the rooms and apparatus of the Normal School of Science, which was seconded by Mr. Shaw, and passed unanimously.

A cordial vote of thanks to the Council and Officers of the past year, moved by Dr. Blaikley and seconded by Prof. Ramsay, was duly acknowledged by the President.

A similar vote, proposed by Mr. Bosanquet and seconded by Mr. Hadden, to the Auditors for the past year was passed unanimously.

The meeting was then resolved into an ordinary science meeting, at which the following papers were read:—

"*On the Limit of Refraction in Relation to Temperature and Chemical Composition.*" By Mr. S. Pelham Dale.

At page 93 of Airy's "Undulatory Theory of Optics" the following formula is given as expressing the velocity of light in an isotropic medium :—

$$v=\sqrt{\left(1-\frac{1}{2^{\frac{3}{2}}}\right)\frac{m}{h}}\;\frac{\sin\frac{\pi h}{\lambda}}{\frac{\pi h}{\lambda}}$$

where m = absolute force of attraction, h = distance between the undulating particles, and λ = wave-length. Reserving λ for wave-lengths in free ether, and l for wave-lengths in the medium, the equation is put in the form—

$$v=k\,\frac{\sin\theta}{\theta}\text{ where }\theta=\frac{\pi h}{l}.$$

If l increases θ diminishes, and the value of v approaches to k as a limit: hence a limit of refraction results. It is shown that the limiting value ν of the index is given by—

$$\nu=\mu\,\frac{\sin\theta}{\theta},$$

where μ is the index corresponding with a value of θ taken as a datum. A method of determining θ is illustrated, and it is shown that, given the indexes corresponding to two wave-lengths in a given medium, the indexes for other wave-lengths can be calculated very approximately. It is also shown that for a given medium, at different temperatures,—

$$\frac{\nu-1}{d}=\text{constant},$$

where d = density of medium, and ν its limited index at the same temperature. In isomeric bodies the same relation obtains closely in a large number of the bodies examined. In all cases examined ν is a quantity not *very* far below μ_A.

"*Note on the Use of the Term 'Resistance' in the Description of Physical Phenomena.*" By Mr. R. H. M. Bosanquet.

The author considers that the term "Resistance" may be conceived of quite generally as the ratio of *cause* to *effect*, and that the fact of this ratio not being constant for magnetic circuits is no reason why the term "magnetic resistance" should be discarded. He maintains that the objections to the employment of the term have been founded on the assumed requirements of *identity* instead of *analogy* between the affections of different subjects, and cannot be sustained; and that the employment of the term "resistance" in the above manner leads to some remarkable analogies which go far to justify independently the use of "*Magnetic Resistance.*"

NOTICES OF BOOKS.

On the Various Modes of Testing for Albumen in Urine. Two Lectures, with Appendix. By G. Johnson, M.D., F.R.S. London: Smith, Elder, and Co.

The purpose of this little book is distinctly medical. The author recommends the testing for albumen and sugar in every case of disease, and seeks to render such investigations easier. He examines the ordinary tests, the application of heat and the use of nitric acid, and he shows under what circumstances they are likely to prove misleading. In preference he recommends the use of picric acid, as more delicate and more certain. Indeed he finds that there is no known substance occurring either in normal or abnormal urine, except albumen, which gives with picric acid a precipitate not re-soluble when heated.

In the second lecture, in which the detection of sugar is discussed, Dr. Johnson proposes as a test picric acid in conjunction with potassa, under which circumstances the picric acid is converted into picramic acid. The urine is mixed with liquor potassæ, heated to boiling, and the picric acid added, when the presence of glucose is at once shown by a deep red colour.

This method the author finds preferable to the fermentation process, and to the tests of Moore, Trommer, Fehling, and Pavy.

Contrary to the opinion of some pathologists, he finds that normal urine contains not a trace of either albumen or glucose.

A Treatise on Chemistry. By Sir H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S. Vol. III. The Chemistry of the Hydrocarbons and their Derivatives or Organic Chemistry. Part IV. London and New York: Macmillan and Co.

This fourth part of the third volume of the authors' great work describes the Toluene, Benzyl, Benzoyl, Hydroxybenzoyl, and Xylene groups. Like the former volumes, the part before us carries the marks of extreme care and diligence in collecting all that has been ascertained concerning the substances in question and the critical treatment of this accumulated matter. The reader is continually referred to original memoirs and dissertations where he may find complete details which could not be introduced in a general treatise.

For the advanced student and as a work of reference the value of this Treatise must remain unchallenged. But its merits render the task of the reviewer superfluous. The Index is elaborate; we have not been able to detect in it any errors.

Quantitative Chemical Analysis by Electrolysis, according to Original Methods. By Dr. Alexander Classen. Authorised Translation from the Second Revised and Enlarged German Edition, by W. H. Herrick. New York: Wiley and Sons. London: Trübner and Co.

In electrolytic analysis Prof. Classen enjoys a reputation similar to that of Mohr in volumetry, or that of Vogel in chemical spectroscopy. The present version will therefore be doubtless welcome to chemists who do not read German with facility.

The author, in his Preface, points out the advantages of electrolytic analysis in its simplicity, it occupying less of the operator's time than ordinary gravimetric processes, and in the high degree of accuracy which may be reached even by comparatively inexperienced analysts.

The first or introductory part of the work describes the various sources of an electric current useful in analytical operations. The author evidently prefers the use of a dynamo wherever the motive power is to be procured. The introduction of resistances is, however, frequently necessary, to reduce the current to the strength required. The reduction of iron, nickel, cobalt, &c., from their solutions needs stronger currents than can be easily obtained from Meininger, Daniell, or Leclanché elements.

The author figures and describes an apparatus to be attached to the dynamo, by means of which a large number of electrolytic determinations can be conducted simultaneously, requiring currents differing in strength and tension, and so that each determination is independent of the rest. According to Siemens and Halske, the constructors, the result is obtained by passing the greater part of the current through a brass wire-gauze resistance, while the individual determinations are made by small branch currents, which may be independently varied in intensity by attaching their conductors to different parts of the resistance.

As regards the process of analysis itself the author recommends the use, as negative electrode, not of a platinum crucible, but of a special thin platinum dish, holding about 225 c.c., and reserved exclusively for this purpose.

As regards the strength of the current to be employed

in different determinations, Prof. Classen remarks that all the measurements of the literature of the subject are "of the current *before* the substance to be decomposed is placed in the circuit, and not, as it ought to be, when both the voltameter and the electrolyte have been introduced."

In the next section we find instructions for the determination of those metals for which electrolysis has been found to give satisfactory results, viz., iron, cobalt, nickel, zinc, manganese, aluminium, chromium, uranium, glucinum, copper, bismuth, cadmium, lead, thallium, silver, mercury, platinum, palladium, gold, antimony, tin, arsenic, and potassium. We then proceed to instructions for the separation of these elements when they occur in combination or mixture.

In the special part we find more detailed directions for the treatment of alloys, ores, slags, furnace-products, commercial metals, &c.

The third part gives tables for calculating out the results of analyses, and a list of the few reagents needed in this department of analysis.

A number of results are appended showing the high degree of accuracy to be attained by the electrolytic method.

Revised and Illustrated Catalogue of Apparatus for Technical Instruction. London: Rigg's Technical Education Appliances, Limited.

The subjects for which these models are adapted are practical plane and solid geometry, machine construction and drawing, building construction, naval architecture, theoretical mechanics, applied mechanics, mining, metallurgy, and steam. The construction of dynamos or other electro-technical machinery, now increasing in importance, does not appear to fall within the limits of the course of instruction in view, which is evidently that of the "Science and Art Department." The models have received medals from the "Healtheries" (Educational Department) and the "Inventories," and appear to be in extensive use, not only in schools at home and in the olonies, but in Japan and in the United States.

A Hand-book of Vegetable and Mineral Products of all Countries, Imported into Great Britain, Geographically arranged, for Use in Schools. By J. H. Silberbach. Liverpool: *Journal of Commerce* Offices.

The idea of this work seems to us decidedly happy. The products are arranged in a column down the middle of each page. On the left we find the countries where they are respectively produced, and to the right are remarks on their sources, preparation, uses, &c. But the manner in which the plan has been carried out is not equally satisfactory. The localities whence products are obtained should, we submit, be arranged in the order of their importance. This is not always the case; some localities of no importance are given, whilst others of very great moment are omitted. Thus we may well be surprised at finding Asiatic Russia and Arabia given as sources of indigo, whilst Guatemala is omitted. We are not aware that sumach is imported from India. We have always known it as a product of Sicily, Italy, Spain, and latterly of some portions of the United States. Under tin we find no mention of the Queensland deposits, which are of no small importance, whilst the yields of Scandinavia and Canada are not of sufficient quantity to tell upon the markets. Perhaps the strangest omission is in the case of wool, where no mention is made of its importation from Australia. There are many more such errors which we have not space to mention.

Nor is the account given of the uses and properties of the products free from errors. Thus, alabaster is not "a carbonate of lime"; the origin of agate is very doubtful; 'baryte" is not "a metal containing valuable components, including sulphur"; beryl is not "a mineral of a blue colour"; logwood is not used as a red dye; safflower is not used for dyeing yellows, but pink and rose shades; it certainly contains, also, yellow colouring-matter, which is carefully got rid of, being useless. Tin is not a "yellow," but a white metal.

Having thus given not a catalogue but a specimen of the inaccuracies of this little work, we cannot recommend it either for schools or as a work of reference for commercial men until it has undergone a very thorough revision.

Playground of Science: a Series of Novel and Interesting Scientific Experiments, Copiously Illustrated. By Johnston Stephen. London: Truelove and Shirley.

We have here a curious little book which may, perhaps, draw the attention of not a few young people in the direction of physical science and its revelations. The experiments described are simple, and may be performed without costly appliances and without danger, but they can scarcely be pronounced as all novel. The Cartesian imps, the floating needle, the lead tree, the cup of Tantalus, &c., have given amusement to generations who have now passed away. We meet with an account of some interesting experiments devised by M. Georges Fournier, and here described under the name of "chemical vegetation." The author does not notice how totally these strange pseudo-organisms differ from crystals, the tubes and cells of which they consist being hollow, and, like the tubes and cells of organisms, containing fluids differing in composition from the enclosing solids.

There is here a curious application of the process of dialysis, which under certain circumstances might be found of practical value. The liquor in which salt provisions have been boiled may in this manner be freed from salt, and may thus be rendered fit for use.

Under the head "Atmospheric Pressure" we find an instance which makes us suspect that the author is not without a vein of dry humour. Says he, "In Scotland some people drink a concoction of whisky, sugar, and water! The bearing of this mixture upon the subject is that it is baled out in wine-glasses by means of tubes similar to pipettes, and manipulated like them, their action, of course, depending upon the pressure of the atmosphere."

The illustrations are numerous and well executed, though in one of them, showing the transmission of sounds through solids, the experimentalist looks no little alarmed at the sounds which reach his ears.

"Pepper's Ghost," now defunct, is duly explained. The author surmises that the Polytechnic ceased to exist because the ghost ceased to walk. We have heard the very opposite theory suggested, that the phantom had become rather a bore than an attraction. We cannot help feeling a slight grudge against the managers of the Polytechnic for giving this device the name "spectrescope," which the public would confound with "spectroscope," so that some troublesome confusion was occasioned.

CORRESPONDENCE.

ON THE THEORY OF THE VITRIOL-CHAMBER PROCESS.

To the Editor of the Chemical News.

Sir,—As I was not present at the last meeting of the Chemical Society, I beg leave to reply in the Chemical News to the remarks made after the reading of my paper "On the Theory of the Vitriol-Chamber Process."

I had myself mentioned the pale colour of the earlier chambers as an argument for the presence of much NO

but there is much more than "a small fraction" of the gases there in a higher state of oxidation, as proved by the numerous analyses formerly made by Naef and myself. I have frequently noticed that a gaseous mixture may contain a somewhat considerable proportion of higher oxides of nitrogen without betraying this by its colour.

It is anything but a novel idea that NO may be reduced in the chambers to N_2O, or even to N_2; the conditions of this process, viz., an excess of SO_2 *and of water*, were first established by R. Weber (*Poggendorff*, vol. cxxx., p. 329), and have been more fully investigated by myself (*Berl. Ber.*, 1881, p. 2196). I then showed that this reaction takes place equally well at the ordinary as at higher temperatures, and, since nobody else ever proved the contrary, this cannot be said to be "usually supposed." On the other hand, the assertion that such a loss is now "generally considered" to take place in the Glover tower is entirely opposed to facts. Some time ago it was certainly affirmed that such a loss did take place; but whoever has followed up the literature of that subject knows that the laboratory experiments then made were proved to be altogether inconclusive, and that no loss whatever in the shape of N_2O through the Glover tower has ever been proved, which can be easily understood, since there is there an excess of acid, not one of water, as required for the reduction of NO to N_2O. The best practical refutation of that now exploded fallacy is the fact that some of the most skilful manufacturers (of whom M. Péchiney, I believe, was the first) pass all their fresh nitric acid down the Glover tower.

The idea that As_2O_3 has anything to do with the reduction of NO to N_2O is probably a confusion with its alleged action in the Gay-Lussac tower, where it is supposed (but hardly proved) to reduce N_2O_3 to NO.—I am, &c.,

George Lunge.

Zurich, February 6, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 4, January 23, 1888.

Action of Vanadic Acid upon the Alkaline Fluorides.—A. Ditte.—On causing vanadic acid to react upon sodium and ammonium fluorides, the author obtains double vanadio-fluorides, analogous to those obtained with potassium fluoride. Vanadic acid attacks also the fluorides of the heavy metals.

Action of Hydrochloric Acid upon Cupric Chloride.—M. Engel.—The result of this reaction is the formation of cupric chloride hydrochlorate, a compound to which the author assigns the formula $CuCl_2,+3H_2O+HCl$. It forms fine needles of a deep garnet red. On exposure to dry air this salt loses hydrochloric acid and turns green.

The Combinations of the Metallic Derivatives of the Phenols with the Mercurous and Cuprous Chlorides.—A. Gabriel Pouchet.—The author prepares these compounds on the following principle: 2 vols. of phenol, liquefied by heat, were mixed with 1 vol. caustic soda at 40° B., the mixture diluted with 10 vols. of water, and a solution of mercuric chloride is added drop by drop, constantly stirring. The precipitate formed re-dissolves at first, but by degrees there is formed a white precipitate with a slight rose shade, which is filtered, washed, and dried in a vacuum.

On the Franceines.—M. Istrati.—The author, whilst endeavouring to obtain sulphonic derivatives of benzene richer in chlorine than any previously known, has observed the production of a series of new and very interesting compounds, almost all possessing tinctorial properties, which he names franceines. All are more or less soluble in alcohol, and yield splendid coloured solutions, intensely dichroic. They dye cotton, linen, wool, and especially silk, in shades ranging from "old rose" to maroon, and even to a deep "*café au lait*."

Determination of Bases in Industrial Phlegms.—M. Lindet.—The author determines the nitrogen by the method of Kjeldahl.

The Alcoholic Fermentation of Galactose.—E. Bourquelot.—The author finds that galactose undergoes the alcoholic fermentation in presence of glucose, levulose, or maltose.

On Galacto-carbonic Acid.—M. Maquenne.—The author has studied this acid, $C_7H_{14}O_8$, and its barium salt.

Zeitschrift fur Analytische Chemie. Vol. xxvi., Part 2.

Universal Dryer.—Kirchner.—A steam-dyeing closet, the description of which is taken from the *Chemiker Zeitung*.

Filtration Apparatus.—P. Casamajor.—From the Chemical News.

Automatic Washing-Apparatus.—Godszatzky.—Reference is made to a figure in Vol. xix. of the *Zeitschrift* (Plate V., Fig. 8).

Gas-Generator.—J. J. Barlow.—From the Chemical News.

A Burette Stand with a Spiral Spring-Clip.—F. Allihn.—The inner side of the clip is pressed against the outer side by a spring contained in the tube-formed arm of the stand.

Distillatory Apparatus for the Purification of Mercury.—H. N. Morse.—From the *American Chemical Journal*.

The Application of Hydrogen Peroxide in Analytical Chemistry.—A Classen and O. Bauer propose to determine the sulphur in all sulphides which, when boiled with hydrochloric acid, dissolve with evolution of sulphuretted hydrogen by means of the oxidation of hydrogen sulphide to sulphuric acid in contact with alkaline hydrogen peroxide. This reagent, however, when free from sulphuric acid, is costly. S. Eliasberg mixes the hydrogen peroxide, accurately neutralised with a measured quantity of an alkali of known strength, and after the sulphuretted hydrogen has been oxidised he determines the excess of alkali with a standard acid.

Separation of Alumina from Titanic Acid.—F. A. Gooch.—From *American Academy of Arts and Sciences*.

Quantitative Separation of Tellurium and Selenium.—E. Divers and M. Schimosé.—From the *Journal of the Chemical Society*.

Volumetric Determination of Soluble Phosphoric Acid in Superphosphates.—A. Emmerling.—This memoir will be inserted at some length.

Detection of Inverted Sugar in Presence of Cane-Sugar.—P. Degener and Schweitzer.—The authors use as a reagent a solution of copper carbonate in a solution of potassium dicarbonate.

The General Applicability of Kjeldahl's Method for the Determination of Nitrogen.—C. Arnold.—The author finds that in azo- and amido-azo-compounds, in nitrites and nitrates, the result is frequently decidedly too low. In diazo-compounds no ammonia is formed. In case of nitrates satisfactory results were obtained by the simultaneous addition of sugar and an excess of benzoic acid.

Determination of Sulphuretted Hydrogen.—J. A. Wanklyn.—From the *Journal of the Society of Chemical Industry*.

Analysis of Gas-waters.—S. Dyson.—From the *Journal of the Society of Chemical Industry.*

Examination of Soap-powders.—Finkener uses a mixture of equal volumes of alcohol at 85 per cent, and of strong acetic acid. He heats 1 grm. of the soap-powder to a boil with 10 to 15 c.c. of this liquid, whereby pure soap-powders give a clear solution, and impurities subside. The clear liquid is decanted off and mixed with twice its volume of water, when the fatty acids separate out on the surface. Carbonates, earthy or alkaline, betray themselves by effervescence.

Distinction between Vegetable and Animal Fibres.—Hans Molisch.—The method depends on the conversion of cellulose into sugar and the detection of the latter. About 0·01 grm. of the fibre, previously well boiled in water and rinsed, is mixed with 1 c.c. water, 2 drops of an alcoholic solution (15 to 20 per cent) of α-naphthol (β-naphthol does not react) and a volume of strongest sulphuric acid equal to the entire liquid. If a plant fibre is present the liquid, on shaking, takes a deep violet colour. Animal fibre tinges the liquid a yellowish or reddish brown. If thymol is used in place of α-naphthol a scarlet-carmine colour appears. According to C. Leuken, menthol is preferable to thymol, giving a cherry-red colour.

Detection of Albumenoids in Wheat Grains.—F. Szymanski.—The grains are steeped for twelve to twenty-four hours in a moderately dilute solution of copper sulphate, freed from excess of liquid by means of blotting-paper, cut into sections, which are then laid in a drop of moderately dilute alkaline lye on the stage.

Micro-chemical Detection of Phloroglucine,—O. Lindt.—The author utilises the reaction produced by hydrochloric acid and vanilline with the phenols. If the liquid is very dilute only orcine and phloroglucine react, the former giving a light blue and the latter red turning to a violet.

Distinction between Purified and Natural Guiacum-Resin.—H. Hager.—This distinction is of some importance, since only the natural resin can be used as a reagent for ozone. 0·15 grm. of the ground resin is dissolved in 5 grms. of absolute alcohol and filtered in the dark. The liquid, with the addition of ten drops oil of turpentine, gives, if the resin has been purified, a dark mixture, turning blue in one or two minutes. The natural resin takes and retains for many hours a yellow colour.

Detection of Pure Castor Oil.—Finkener.

Determination of Mercury Chloride in Sublimate Soap.—O. Kaspar and E. Geissler.

Examination of Chloral Hydrate.—A. Kremel.

Examination of Balsams, Resins, and Gum-resins.—A. Kremel.—For these four papers we must refer to the original.

Detection of Hyposulphurous Acid in Urine.—E. Salkowski.—The author distils 100 c.c. of the urine with 10 c.c. of hydrochloric acid of sp. gr. 1·12 down to one-fourth of the original volume. The sulphur separated off is deposited in the upper part of the condenser.

Determination of Nitrogen in the Urine and the Milk of the Herbivora.—H. Weiske.—The methods of Varrentrapp-Will and of Kjeldahl yielded concordant results.

Determination of Urea with Sodium Hypobromite.—J. Marshall.—The author uses a modification of the apparatus of Greene.

Distinction between Chrysophanic Acid and the Colouring-Matter of Santonin in Urine.—G Hoppe-Seyler.—The urine is rendered alkaline with soda and shaken up with amylic alcohol. The colour of santonine passes into the alcohol, whilst chrysophanic acid does not.

The Luminosity of Phosphorus.—K. Polstorff and J. Mensching.—This phenomenon is suppressed by the presence of mercuric chloride and of phenol.

The Hæmidine Crystals of Dannenberg.—These crystals are merely sulphur.

Contributions to Forensic Chemistry.—G. Dragendorff.—Researches on the effects of medicines on different parts of the body, as found on *post mortem* examinations.

The Atomic Weight of Germanium.—A. Winkler.—The author obtains the mean value 72·32, which agrees very closely with the figure predicted by Mendeleeff, *i.e.*, about 72.

Recalculation of the Results of the Determinations of Stas.—J. D. Van der Plaats.—The author finds that silver, as obtained by the method of Stas, contains no oxygen, and that consequently the objections of Dumas against the atomic weights as determined by Stas are unfounded.

MISCELLANEOUS.

Dr. Carnelley's Gift of a Museum to University College, Dundee.—Mr. D'Arcy W. Thompson writes as follows to the *Dundee Advertiser*, of Jan. 24th:—"Your readers may recollect that some three months ago Dr. Forbes Watson, the well-known authority on Indian produce, offered his great collection of commercial products to the University of Anerdeen at the comparatively small price of £250. I begged Dr. Forbes Watson to make the same offer to us, in the remote event of its refusal by Aberdeen, and he agreed, telling me that he had hesitated whether to offer the collection in the first instance to Dundee, to whose staple trade very many of the samples are closely related. The Town Council of Aberdeen promised a subscription of £50 towards the purchase money, but, nevertheless, the University authorities, after three months' deliberation, found themselves unable to raise the sum, and regretfully declined the offer. On Thursday last Dr. Forbes Watson wrote me to this effect, and to make his promised offer to us. I discussed the matter with my colleague Dr. Carnelley. He left the same evening for London, and wrote me the next day that his father and he had purchased the collection to present it to our college. No help has ever been given this college so promptly or more judiciously. This excellent gift puts us at once in possession of a museum which is first-class of its kind, and of which town and college should be proud for ever. Dr. Forbes Watson is well-known to many of the older men in Dundee for his knowledge of jute and all other commercial fibres. His works are standard on the subject. His collection was amassed with unrivalled opportunities and the highest technical skill. Great part of it was brought together as an official duty for the Indian Museum, and was presented by the department to Dr. Forbes Watson when that museum was broken up. It contains nearly 7500 samples. Between 700 and 800 of these are fibres, including textiles and paper-making materials. There are over 500 dyes and dye stuffs, 500 oils and oil seeds, 600 or 700 gums, resins, and guttas, nearly 2000 medicinal substances (may they be useful to us in the future), and more than as many samples of food stuffs. The bulk of the collection is stored in bottles, filling fourteen cabinets, and there are also stands and cases for the display of specimens. Altogether the cases and bottles in which this great collection is stored represent a cost greater than the price which Dr. Forbes Watson now asks and receives. The opportunity was a golden one. But such opportunities are not so rare as are the wisdon and kindliness with which this one has been seized.

Method of Observing the Action of Magnets on Liquids.—S. T. Morehead.—Recently one of my students, Mr. J. C. Child, and myself were working with a diamagnetic instrument, simply repeating well known experiments. Plücker's method of observing the diamagnetism

of liquids having failed in our hands to give satisfactory results, we hit upon a method which was new to us and which was very satisfactory. Into a glass tube of about four or five millimetres internal diameter a small quantity of liquid was introduced forming a short cylinder. This this tube was placed horizontally at right angles to the line joining the poles of the magnet with the liquid nearly between the poles. When the current was turned on the liquid was very evidently repelled. Water was repelled through a distance of about half a centimetre; wood spirit through a greater distance. By moving the tube in the direction of its length the wood spirit could be pushed any distance through the tube. The amount of motion is of course a function of the resistances due to adhesion and friction as well as of the repulsive force. The attraction of liquids is easily shown by the same method. A single modification of the above plan of proceeding is to incline the tube slightly so as to make the liquid flow toward the poles. If the required velocity be not too great the magnet acts as a break to stop the motion. It is well to bend the tube up a little at each end to prevent the liquids from flowing out. This method is well adapted for projection so as to be seen by large audiences.—*American Journal of Science*, Vol. xxxiv., No. 201.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Healing Properties of Gold (Reply to Bertha Körter).—"The reason why gold wires are inserted into holes made in the ears is rather chemical than medical. Gold is not acted on by the fluids of the wounded part, and consequently irritant compounds which might prevent healing are not formed. . . . The notion of the healing nature of gold is simply an exploded notion. The gold has no active healing power, but it does not interfere with healing, as other metals through the chemical compounds formed."—*British Medical Journal*, Sept. 24, 1881, p. 544. Hoping this extract will set at rest Bertha Körter's question as to the healing properties of gold (see Chemical News, vol. lvi., p. 140).—Mary Shoonen.

MEETINGS FOR THE WEEK.

Monday, 20th.—Medical, 8.30.
— Society of Chemical Industry, 8. "The Bromine Absorption of Mineral Oils," by J. B. McArthur. "Note on Camphor Oil and Oil of Sunflower," by Mr. Kingzett. "On a New Series of Cotton Colouring-matters," by A. G. Green. "Note on Kjeldahl's Method of Nitrogen Determination," by Professor Meldola and E. H. Moritz.
— Society of Arts, 8. "Yeast, its Morphology and Culture," by A. Gordon Salamon, F.C.S.
Tuesday, 21st.—Institution of Civil Engineers, 8.
— Pathological, 8.30.
— Royal Institution, 3. "Before and After Darwin," by George John Romanes, F.R.S.
Wednesday, 22nd.—Society of Arts, 8. "The Technical Education Bill," by Swire Smith.
Thursday, 23rd.—Royal, 4.30.
— Royal Society Club, 6.30.
— Telegraphic Engineers, 8.
— Royal Institution 3. "Early Secular Choral Music," by Prof. Hubert H. Parry, M.A.
Friday, 24th.—Quekett Club, 8. (Anniversary).
— Society of Arts, 8. "Facts Regarding the Religions of India, and their Influences on the Social Progress of the People," by Sir William W. Hunter, K.C.S.I., C.I.E., LL.D.
— Royal Institution 9. "Westminster Abbey," by The Very Rev. G. Granville Bradley, D.D., Dean of Westminster.
Saturday, 25th.—Royal Institution, 3. "Experimental Optics," by the Right Hon. Lord Rayleigh.
— Physical, 3. "Note on the Efficiency of Incandescent Lamps with Direct and Alternate Currents," by Prof. W. Ayrton, F.R.S., and Prof. John Perry, F.R.S. "Observations on the Height and Length of Ocean Waves," by Hon. Ralph Abercrombie. "Experiments on Electrolysis," by W. W. Haldane Gee. "On the Temperature at which Nickel begins suddenly to Lose its Magnetic Properties," by Herbert Tomlinson.

Just published, Crown 8vo., Cloth, 12s. 6d.
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By C. F. CROSS and E. J. BEVAN.
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BOROUGH OF BIRMINGHAM.
GAS DEPARTMENT.
The Gas Committee of the Corporation of BIRMINGHAM are prepared to receive Tenders for the Tar to be produced at their various Works from the 30th of June next, for a period of one or two years, or for one year and then subject to termination of the contract on three months' notice on either side.
The quantities to be dealt with in the year ending 30th June, 1889, are estimated as follows:—
Saltby Works, 9000 tons.
Windsor St. Works, 7300 tons.
Adderley St. Works, 2400 tons.
Swan Village Works, 2550 tons.
The Committee will receive Tenders either at a fixed price per ton or at a varying price to be calculated on the actual returns obtained from time to time on the sale of the products derived from the Tar, provided that in such case the Contractor is dealing only with the Corporation Tar.
The Corporation will be willing to let on lease Land on which Tar Works could be erected, or they would erect Works on their own land and let them to the Contractor.
Forms and Conditions of Tender may be obtained on application to me,
EDWIN SMITH, Secretary.
Borough Gas Office, Council House,
Birmingham, December 31, 1887.

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THE CHEMICAL NEWS.

Vol. LVII. No. 1474.

ON THE RELATIVE DENSITIES OF HYDROGEN AND OXYGEN.

Preliminary Notice.*

By Lord RAYLEIGH, Sec. R.S.,
Professor of Natural Philosophy in the Royal Institution.

The appearance of Prof. Cooke's important memoir upon the atomic weights of hydrogen and oxygen† induces me to communicate to the Royal Society a notice of the results that I have obtained with respect to the relative *densities* of these gases. My motive for undertaking this investigation, planned in 1882,‡ was the same as that which animated Prof. Cooke, namely, the desire to examine whether the relative atomic weights of the two bodies really deviated from the simple ratio 1 : 16, demanded by Prout's Law. For this purpose a knowledge of the densities is not of itself sufficient; but it appeared to me that the other factor involved, viz., the relative atomic *volumes* of the two gases, could be measured with great accuracy by eudiometric methods, and I was aware that Mr. Scott had in view a re-determination of this number, since in great part carried out.§ If both investigations are conducted with gases under the normal atmospheric conditions as to temperature and pressure, any small departures from the laws of Boyle and Charles will be practically without influence upon the final number representing the ratio of atomic weights.

In weighing the gas the procedure of Regnault was adopted, the working globe being compensated by a similar closed globe of the same external volume, made of the same kind of glass, and of nearly the same weight. In this way the weighings are rendered independent of the atmospheric conditions, and only small weights are required. The weight of the globe used in the experiments here to be described was about 200 grms., and the contents were about 1800 c.c.

The balance is by Oertling, and readings with successive releasements of the beam and pans, but without removal of the globes, usually agreed to 1-10th m.grm. Each recorded weighing is the mean of the results of several releasements.

The balance was situated in a cellar, where temperature was very constant, but at certain times the air currents, described by Prof. Cooke, were very plainly noticeable. The beam left swinging over night would be found still in motion when the weighings were commenced on the following morning. At other times these currents were absent, and the beam would settle down to almost absolute rest. This difference of behaviour was found to depend upon the distribution of temperature at various levels in the rooms. A delicate thermopile with reflecting cones was arranged so that one cone pointed towards the ceiling and the other to the floor. When the galvanometer indicated that the ceiling was the warmer, the balance behaved well, and *vice versâ*. The reason is, of course, that air is stable when the temperature increases upwards, and unstable when heat is communicated below. During the winter months the ground was usually warmer than the rest of the room, and air currents developed themselves in the weighing closet. During the summer the air cooled by contact with the ground remained as a layer below, and the balance was undisturbed.

The principal difference to be noted between my arrangements and those of Prof. Cooke is that in my case no desiccators were used within the weighing closet. The general air of the room was prevented from getting too damp by means of a large blanket, occasionally removed and dried before a fire.*

In Regnault's experiments the globe was filled with gas to the atmospheric pressure (determined by an independent barometer), and the temperature was maintained at zero by a bath of ice. The use of ice is no doubt to be recommended in the case of the heavier gases; but it involves a cleaning of the globe, and therefore diminishes somewhat the comparability of the weighings, vacuous and full, on which everything depends. Hydrogen is so light that, except perhaps in the mean of a long series, the error of weighing is likely to be more serious than the uncertainty of temperature. I have therefore contented myself with enclosing the body of the globe during the process of filling in a wooden box, into which passed the bulbs of two thermometers, reading to tenths of a degree centigrade. It seems probable that the mean of the readings represents the temperature of the gas to about 1 10th degree, or at any rate that the differences of temperature on various occasions and with various gases will be given to at least this degree of accuracy. Indeed the results obtained with oxygen exclude a greater uncertainty.

Under these conditions the alternate full and empty weighings can be effected with the minimum of interference with the surface of the globe. The stalk and tap were only touched with a glove, and the body of the globe was scarcely touched at all. To make the symmetry as complete as possible, the counterpoising globe was provided with a similar case, and was carried backwards and forwards between the balance room and the laboratory exactly as was necessary for the working globe.

In my earliest experiments (1885) hydrogen and oxygen were prepared simultaneously in a U-shaped voltameter containing dilute sulphuric acid. Since the same quantity of acid can be used indefinitely, I hoped in this way to eliminate all extraneous impurity, and to obtain hydrogen contaminated only by small quantities of oxygen, and *vice versa*. The final purification of the gases was to be effected by passing them through red-hot tubes, and subsequent desiccation with phosphoric anhydride. In a few trials I did not succeed in obtaining good hydrogen, a result which I was inclined to attribute to the inadequacy of a red heat to effect the combination of the small residue of oxygen.† Meeting this difficulty, I abandoned the method for a time, purposing to recur to it after I had obtained experience with the more usual methods of preparing the gases. In this part of the investigation my experience runs nearly parallel with that of Prof. Cooke. The difficulty of getting quit of the dissolved air when, as in the ordinary preparation of hydrogen, the acid is fed in slowly at the time of working, induced me to design an apparatus whose action can be suspended by breaking an external electrical contact. It may be regarded as a Smee cell thoroughly enclosed. Two points of difference may be noted between this apparatus and that of Prof. Cooke. In my manner of working it was necessary that the generator should stand an internal vacuum. To guard more thoroughly against the penetration of external air, every cemented joint was completely covered with vaseline, and the vaseline again with water. Again, the zincs were in the form of solid sheets, closely surrounding the platinised plate on which the hydrogen was liberated, and standing in mercury. It was found far better to work these cells

* A Paper read before the Royal Society, February 9th, 1888.

† "The Relative Values of the Atomic Weights of Hydrogen and Oxygen," by J. P. Cooke and T. W. Richards, *Amer. Acad. Proc.*, vol xxiii., 1887.

‡ Address to Section A, British Association "Report," 1882.

§ "On the Composition of Water by Volume," by A. Scott, *Roy. Soc. Proc.*, June 16, 1887 (vol. xlii., p. 396).

* I can strongly recommend this method. In twenty-four hours the blanket will frequently absorb 2 lbs. of moisture.

† From Prof. Cooke's experience it appears not improbable that the impurity may have been sulphurous acid. Is it certain that in his combustions no hydrogen (towards the close largely diluted with nitrogen) escapes the action of the cupric oxide?

by their own electromotive force, without stimulation by an external battery. If the plates are close, and the contact wires thick, the evolution of gas may be made more rapid than is necessary or indeed desirable.

Tubes, closed by drowned stopcocks, are provided, in order to allow the acid to be renewed without breaking joints; but one charge is sufficient for a set of experiments (three to five fillings), and during the whole of the time occupied (ten to fourteen days) there is no access of atmospheric air. The removal of dissolved air (and other volatile impurity) proved, however, not to be so easy as had been expected, even when assisted by repeated exhaustions, with intermittent evolution of hydrogen; and the results often showed a progressive improvement in the hydrogen, even after a somewhat prolonged preliminary treatment. In subsequent experiments greater precautions will be taken.* Experience showed that good hydrogen could not thus be obtained from zinc and ordinary "pure" sulphuric acid, or phosphoric acid, without the aid of purifying agents. The best results so far have been from sulphuric and hydrochloric acid, when the gas is passed in succession over liquid potash, through powdered corrosive sublimate, and then through powdered caustic potash. All the joints of the purifying tubes are connected by fusion, and a tap separates the damp from the dry side of the apparatus. The latter includes a large and long tube charged with phosphoric anhydride, a cotton-wool filter, a blow-off tube sealed with mercury until the filling is completed, besides the globe itself and the Töppler pump. A detailed description is postponed until the experiments are complete. It may be sufficient to mention that there is but one india-rubber connexion, —that between the globe and the rest of the apparatus,— and that the leakage through this was usually measured by the Töppler before commencing a filling or an evacuation.

The object of giving a considerable capacity to the phosphoric tube was to provide against the danger of a too rapid passage of gas through the purifying tubes at the commencement of a filling. Suppose the gas to be blowing off, all the apparatus except the globe (and the Töppler) being at a pressure somewhat above the atmospheric. The tap between the damp and dry sides is then closed, and that into the globe is opened. The gas which now enters somewhat rapidly is thoroughly dry, having been in good contact with the phosphoric anhydride. In this way the pressure on the dry side is reduced to about 2 inches of mercury, but this residue is sufficient to allow the damp side of the apparatus to be exhausted to a still lower pressure before the tap between the two sides of the apparatus is re-opened. When this is done, the first movement of the gas is retrograde, and there is no danger at any stage of imperfect purification. The generator is then re-started until the gas (after from two to five hours) begins to blow off again.

In closing the globe some precaution is required to secure that the pressure therein shall really be that measured by the barometer. The mercury seal is at some distance from, and at a lower level than, the rest of the apparatus. After removal of the mercury the flow of gas is continued for about one minute, and then the tap between the dry and damp sides is closed. From three to five minutes more were usually allowed for the complete establishment of equilibrium before the tap of the globe was turned off. Experiments on oxygen appeared to show that two minutes was sufficient. For measuring the atmospheric pressure *two* standard mercury barometers were employed.

The evacuations were effected by the Töppler to at least $\frac{1}{10000}$, so that the residual gas (at any rate after one filling with hydrogen) could be neglected.

I will now give some examples of actual results. Those in the following tables relate to gas prepared from *sulphuric* acid, with subsequent purification, as already described:—

Globe (14), empty.

Date. 1887.	Left.	Right.	Balance reading.
Oct. 27 to Nov. 5 ..	$G_{14}+0{\cdot}394$	G_{11}	22·66
Nov. 7 to Nov. 8 ..	—	—	22·89
Nov. 9 to Nov. 10 ..	—	—	23·00
Nov. 11 to Nov. 12 ..	—	—	21·72

Globe (14), full.

Date. 1887.	Left.	Right.	Balance reading.	Barometer. In.	Temperature. C.
Nov. 5 to 7..	$G_{14}+0{\cdot}2400$	G_{11}	20·52	29·416	14·7°
Nov. 8 to 9..	$G_{14}+0{\cdot}2364$	G_{11}	19·77	29·830	12·3°
Nov. 10 to 11..	$G_{14}+0{\cdot}2360$	G_{11}	19·18	22·807	11·2°
Nov. 12 to 14..	$G_{14}+0{\cdot}2340$	G_{11}	19·51	30·135	10·3°

The second column shows that globe (14) and certain platinum weights were suspended from the left end of the beam, and the third column that (in this series) only the counterpoising globe (11) was hung from the right end. The fourth column gives the mean balance reading in divisions of the scale, each of which (at the time of the above experiments) represented 0·000187 grm. The degree of agreement of these numbers in the first part of the table gives an idea of the errors due to the balance, and to uncertainties in the condition of the exteriors of the globes. A minute and unsystematic correction depending upon imperfect compensation of volumes (to the extent of about 2 c.c.) need not here be regarded.

The weight of the hydrogen at each filling is deduced, whenever possible, by comparison of the "full" reading with the mean of the immediately preceding and following "empty" readings. The difference interpreted in grms. is taken provisionally as the weight of the gas. Thus for the filling of Nov. 5:—

$$H = 0{\cdot}154 - 2{\cdot}25 \times 0{\cdot}000187 = 0{\cdot}15358.$$

The weights thus obtained depend of course upon the temperature and pressure at the time of filling. Reduced to correspond with a temperature of 12°, and to a barometric height of 30 inches (but without a minute correction for varying temperature of the mercury) they stand thus:—

November 5	0·15811
,, 8	0·15807
,, 10	0·15798
,, 12	0·15792
Mean	0·15802

The hydrogen obtained hitherto with similar apparatus and purifying tubes from hydrochloric acid is not quite so light, the mean of two accordant series being 0·15812.

The weighing of oxygen is of course a much easier operation than in the case of hydrogen. The gas was prepared from chlorate of potash, and from a mixture of the chlorates of potash and soda. The discrepancies between the individual weighings were no more than might fairly be attributed to thermometric and manometric errors. The result reduced so as to correspond in all respects with the numbers for hydrogen is 2·5186.*

But before these numbers can be compared with the object of obtaining the relative densities, a correction of some importance is required, which appears to have been overlooked by Professor Cooke, as it was by Regnault. The weight of the gas is *not* to be found by merely taking the difference of the full and empty weighings, unless indeed the weighings are conducted *in vacuo*. The external volume of the globe is larger when it is full than when it is empty, and the weight of the air corresponding to this difference of volume must be *added* to the apparent weight of the gas.

By filling the globe with carefully boiled water, it is not difficult to determine experimentally the expansion per

* Spectrum analysis appears to be incapable of indicating the presence of comparatively large quantities of nitrogen.

* An examination of the weights revealed no error worth taking into account at present.

atmosphere. In the case of globe (14) it appears that under normal atmospheric conditions the quantity to be added to the apparent weights of the hydrogen and oxygen is 0·00056 grm.

The actually observed alteration of volume (regard being had to the compressibility of water) agrees very nearly with an *à priori* estimate, founded upon the theory of thin spherical elastic shells and the known properties of glass. The proportional value of the required correction, in my case about $\frac{4}{1000}$ of the weight of the hydrogen, will be for spherical globes proportional to a/t where a is the radius of the globe, and t the thickness of the shell, or to V/W, if V be the contents and W the weight of the glass. This ratio is nearly the same for Professor Cooke's globe and for mine; but the much greater departure of his globe from the spherical form may increase the amount of the correction which ought to be introduced.

In the estimates now to be given, which must be regarded as provisional, the apparent weight of the hydrogen is taken at 0·15804, so that the real weight is 0·15860. The weight of the same volume of oxygen under the same conditions is 2·5186 + 0·0006 = 2·5192. The ratio of these numbers is 15·884.

The ratio of densities found by Regnault was 15·964, but the greater part of the difference may well be accounted for by the omission of the correction just now considered. In order to interpret our result as a ratio of atomic weights, we need to know accurately the ratio of atomic volumes. The number given as most probable by Mr. Scott in May, 1887,* was 1·994, but he informs me that more recent experiments under improved conditions give 1·9965. Combining this with the ratio of densities, we obtain as the ratio of atomic weights:—

$$\frac{2 \times 15{\cdot}884}{1{\cdot}9965} = 15{\cdot}912$$

It is not improbable that experiments conducted on the same lines, but with still greater precautions, may raise the final number by one or even two thousandths of its value.

The ratio obtained by Professor Cooke is 15·953; but the difference between this number and that above obtained may be more than accounted for, if I am right in my suggestion that his gas weighings require correction for the diminished bouyancy of the globe when the internal pressure is removed.

ON THE

CONSTANCY IN THE HEAT PRODUCED BY THE REACTION OF CERTAIN SALTS ON EACH OTHER.

By SPENCER U. PICKERING.

THERE seems to be an adverse fate which prevents chemists from understanding the thermal phenomena of neutralisation. For the fourth time I beg to point out errors which have been made through a misunderstanding of these facts by authors of papers which have appeared in the CHEMICAL NEWS.

In a communication by T. W. Richards (lvii., 16), extracted from the *Proceedings of the American Academy of Arts and Sciences*, the author precipitates solutions of various metallic chlorides by a solution of silver nitrate, and finds that the heat evolved is a constant quantity, viz., 16,165 cals., and hence concludes that "the difference between the heats of formation of equivalent amounts of nitrates and chlorides in aqueous solution is the same for any metal or basic radical." Now this conclusion, though correct, is simply a consequence of the fact ascertained by Thomsen, that the heat of neutralisation of any alkali by hydrochloric or nitric acid is a constant quantity, independent of the nature of the base. These results may be expressed, as I have shown (*Chem. Soc. Trans.*, 1887, 594) by the equation—

$$M,Cl,Aq - M',Cl,Aq = M,(NO_3),Aq - M',(NO_3),Aq,$$

in which M and M' represent equivalents of any metallic radicles. Now, when we precipitate a metallic chloride (say KCl) in solution by silver nitrate, the actions taking place are—

Decomposition of KCl sol.;	Decomposition of $AgNO_3$ sol.;
$- K,Cl,Aq$	$- Ag,NO_3,Aq$ +
Formation of KNO_3 sol.;	Formation of AgCl ppt.;
$K,(NO_3),Aq$	+ Ag,Cl

and must give the same results as in the case of any other metallic chloride—

$$= -Na,Cl,Aq - Ag,(NO_3),Aq + Na,(NO_3),Aq + Ag,Cl$$

for the equation simplifies down into

$$-K,Cl,Aq + K,(NO_3),Aq - Na,Cl,Aq + Na,(NO_3),Aq,$$

which, from the results of neutralisation above quoted, = O.

The heat evolved in each experiment (16,165 cals.), is, in fact, merely the heat of precipitation of silver chloride, the separate determinations showing the somewhat large error of ± 160 cals. This will be evident from the following considerations:—

The heat of formation of a salt in solution, such as K,Cl,Aq, is given, as I have shown (*loc. sup. cit.*), by the equation $(K,Aq) + (HCl,Ag^*) + N$, in which N represents the heat of neutralisation of hydrochloric acid by potash, while the heat of formation of the same salt in the solid state is represented by this quantity, *minus* the heat of dissolution of the salt, D. Thus the equation—

$$-K,Cl,Aq - Ag,(NO_3),Aq + K,NO_3,Aq + Ag,Cl$$

becomes—

$$-[K,Aq + H,Cl,Aq + N_1] - [Ag,\dagger Aq + H,NO_3,Aq + N_2] + [K,Aq + K,(NO_3),Aq + N_3] + [Ag,Aq + H,Cl,Aq + N_4 - D]$$
$$= 16{,}165 \text{ cals.}$$

N_1, N_2, N_3, and N_4 all being equal, this simplifies into—

$$-D = 16{,}165 \text{ cals.}$$

The same conclusions may be drawn by regarding the equation $-K,Cl,Aq$, &c., as a special instance of the general equation—

$$M,Cl,Aq - M',Cl,Aq = M,(NO_3),Aq - M',(NO_3),Aq,$$

Ag,Cl being, of course, equal to Ag,Cl,Aq − D.

Mr. Richards's experiments were followed by a similar investigation by I. W. Fay (CHEMICAL NEWS, lvii., p. 36), in which metallic sulphates were precipitated by a solution of barium chloride, and here the heat evolved in the reaction represents, as in Mr. Richards's experiments, the heat of precipitation of the insoluble salt—barium sulphate in this case. It is only, however, when dealing with dyad metals that the heat evolved represents this quantity, for in these cases only do the values of the heat of neutralisation cancel. There is a constant difference between the heat of neutralisation of an alkali by hydrochloric acid and sulphuric acid with dyad metals, or, in the above equation—

$$-N_1 - N_2 + N_3 + N_4 = O.$$

Where the chloride taken is that of a monad metal—

$$(N_3 - N_1) > (N_4 - N_2)$$

therefore the heat produced will be less‡ than the heat of precipitation of barium sulphate by the amount of the difference between these two quantities, whereas if the chloride be that of a pseudo-triad metal, then—

$$(N_3 - N_1) < (N_4 - N_2),$$

* *Loc. cit.*

* The heat of dissolution of the acid in water was accidentally omitted in the communication referred to.

† The dissolution of silver in water is of course an hypothetical reaction, but since it occurs twice with opposite signs in the equation, this is immaterial.

‡ $(N_3 - N_1)$ is a negative quantity.

and the heat produced will be increased by the difference between these two quantities (see Pickering, *Chem. Soc. Trans.*, 1887, 598). This explains the want of constancy observed by Mr. Fay in the various cases.

The fact that there is a constant difference in the heats of neutralisation by sulphuric and hydrochloric acids in the case of dyad metals only is probably due, as I have already suggested, to the exercise of residual affinity between the two metallic atoms present in the sulphate molecules in other cases.

It is interesting to compare Mr. Fay's results with those obtained by Thomsen. The third column in the accompanying table gives Thomsen's numbers obtained in the direct precipitation of the sulphate by barium chloride, as in Mr. Fay's experiments; from these results, in the case of the dyad metals Mg, Mn, Co, Cd, Zn, and Cu, Thomsen deduces the value for the precipitation of barium sulphate to be 5580 cals., and this quantity + the differences in the heat of neutralisation—

$$[(N_3-N_1)-(N_4-N_2)],$$

gives the indirect values in the cases of other metals, as quoted in the second column. With ferric sulphate only is there any very great difference between Thomsen's and Mr. Fay's results.

Precipitation of Sulphates by Barium Chloride.

M	Thomsen. Indirect.	Thomsen. Direct.	Fay. Direct.
H_2	9120	—	9904
Na_2	5230	5240	5180
K_2	5330	5280	5594
Li_2..	5530	—	—
Tl_2..	5510	—	—
Am_2.	5510	5408	5556
Sr	6040	—	—
Ca	5880	—	—
Mg	—	5600	5556
Mn	—	5600	—
Co	—	5688	5736
Ni	—	—	5736
Fe	—	—	5817
Cd	—	5683	5776
Zn	—	5504	5556
Cu	—	5616	5534
$\frac{1}{3}Be_2$.	—	6660	—
$\frac{1}{3}Fe_2$.	—	9144	6864
$\frac{1}{3}La_2$.	—	6671	—
$\frac{1}{3}Al_2$.	—	—	6504
$\frac{1}{3}Ce_2$.	—	7254	—
$\frac{1}{3}Di_2$.	—	7380	—
$\frac{1}{3}Y_2$	—	7614	—
$\frac{1}{4}K_2Al_2$	—	6407	6624
$\frac{1}{4}K_2Cr_2$	—	6136	6324
$\frac{1}{4}Am_2Fe_2$. ..	—	—	8280

EXAMINATION OF A QUARTZ CONGLOMERATE FROM WITWATERSRAND (TRANSVAAL).

By PHILIP HOLLAND.

The Witwatersrand (the ridge or hill of white waters), so called from the clear pellucid character of the streams that flow from it, is the name given in the Transvaal to a tract of undulating country standing 6000 feet above the sea. The chief town of the district, Johannesberg, lies some 40 miles to the south of Pretoria.

Gold was found in the "Rand" by Mr. Struben in the spring of 1886, and the district was proclaimed a public gold-field in the autumn of the same year.

The Witwatersrand has of late attracted considerable attention, an attention doubtless justified by the richness of the reefs, their extent, and the facility with which the gold-bearing material can be quarried. Much of this consists of a loose quartz conglomerate, easy to win by pick and spade, though in many places the deposit presents the appearance of a compact quartzite. The reef crops out in certain localities, but for the most part lies 2 feet or so below the present surface. The colour varies between a light yellow and a dark reddish brown. Some kinds incline to a purplish brown. A specimen which I owe to the courtesy of Mr. Henry de Stedingk is one of the darker varieties. When received, a few of the smaller pebbles were found still imbedded in the siliceous matrix. The larger pebbles had doubtless become separated in transit. The appearance the sample presented on arrival was that of a mixture of rounded, water-worn, quartz pebbles, with angular fragments of quartzose sandstone, the quartz grains composing the latter being for the most part of the size of a millet seed, a smaller proportion being of larger size; the remainder of the sample, representing nearly 50 per cent of the whole, consisted of coarse gravelly sand. On washing a small quantity of the sand by elutriation it was easy to distinguish minute flakes of mica. I collected a few by the aid of a pipette, and on treating them with HF a solution was obtained that gave the spectroscopic reaction for potash well.

On treating a portion of the original sample in the same manner, and separating the iron and alumina oxides by ammonia, the spectrum of lithia was faintly visible.

The original sample did not contain "visible gold" in the sense in which this term is popularly understood, though, whilst washing some of the gravelly sand in the way described, there appeared now and again a glistening particle suggestive of gold.

The weight of the sample of reef deposit when received was 9 lbs., of which 4 lbs. 10 ozs. readily passed through a ¼-inch mesh. It may be useful to give the weights of a few pebbles and fragments of sandstone that failed to pass the mesh. The largest stone in the sample, a sandstone fragment, weighed 41·33 grms.; the next in size, a quartz pebble, 35·14 grms.; the mean weight for one of twelve smaller stones, apparently alike in size, was 31·7 grms.; taking fifty, still smaller, the weight of one was 14·4 grms.; taking again fifty stones, apparently half the size of the last, the weight of one stone was 8·7 grms. These figures may serve to give some idea of the coarseness of the matter composing the conglomerate. On completion of the weighings the whole sample was re-united, mixed as uniformly as was practicable, and then divided in two portions, A and B. In A, which was all reduced to fine powder, the gold was extracted by the wet method on quantities of from 1 to 1½ lbs. A qualitative analysis was also made on this portion, special attention being directed to the detection of bismuth, the oxide of which was recently found by H. Louis in auriferous quartz from the Leydenburg district of the Transvaal. I did not, however, detect bismuth, nor in fact any of the less commonly occurring oxides, in my specimen of the Witwatersrand deposit.

To return to portion B of the divided sample: this was sifted, and all that passed the ¼-inch mesh was also reduced to powder and assayed for gold, precisely as A. Before, however, I set down the few assays made on my specimen of conglomerate, it will be instructive to give some figures obtained by Mr. Dawson, F.I.C., F.C.S., Analyst to the Government of the South African Republic. The figures are taken from the "Transvaal Almanac" of last year, published at Pretoria. The Editor of the Almanac remarks that—

"Mr. Dawson has favoured him with the average of between 400 and 500 trials of conglomerate from various reefs extending over the whole of the known Heidelberg Gold-fields. The average produce of the whole series of assays (including a test-crushing of 25 tons, which yielded 1 oz. 8 dwts. per ton) is equal to 3 ozs. 5 dwts. 12 grs. per ton. That includes very rich specimens, yielding over 5 ozs. per ton. As regards the percentage return, which will perhaps afford a better indication of the general run of ores, the statement is as follows:—

	Per cent.
Under 1 oz. per ton	48·9
„ 2 ozs. „	23·1
„ 3 „ „	7·5
Above 3 „ „	20·5

"It will thus be seen that nearly 50 per cent of the conglomerate at Witwatersrand yields less than 1 oz. per ton, whilst upwards of 20 per cent produces over 3 ozs. per ton."

The following are my assays of portion A, which show it to belong to the poorer descriptions of ore:—

Gold per ton.

Dwts.	Grs.
15	3
15	20
15	6½

The sifted material from the reserved portion B of the original sample yielded per ton—

Ozs.	Dwts.	Grs.
1	3	$1\frac{3}{10}$
1	2	16

I regret my inability to give a larger number of tests of this interesting deposit; but they are useful in that they confirm a current statement regarding the Witwatersrand conglomerate, viz., that the gold is found principally in the matrix or cement that binds the pebbles together, though not confined to it entirely.

An analysis of the sifted material was made to show its general composition:—

SiO_2	85·720
Al_2O_3	4·270
Fe_2O_3	6·180
TiO_2	0·115
MnO	0·025
CaO	0·010
MgO	trace
K_2O	0·227
Na_2O	0·318
Organic matter	0·290
Water	2·560
	99·715

The alkalies, I presume, may be set down to the mica. The organic matter will be traceable doubtless to partially decayed vegetable fibres and humic substances.

RIDSDALE'S SIMPLIFIED CHROMOMETER FOR MODERATELY DEEP TINTS.

At the meeting of the Newcastle Section of the Society of Chemical Industry, February 7th, 1888, Mr. C. H. Ridsdale, F.I.C., F.C.S., read a short paper on the above apparatus.

It is for the rapid comparison of solutions of various depths of tint with a standard solution of similar tint, with a view to determining the quantity of the particular constituent present.

Hence it can be used for any chromometric method, —such as the estimation of *carbon* in all classes of steel; *copper* in wrought-iron, pig-iron, steel, ferro-manganese, iron ores, &c.; *manganese* in steel; *ammonia* in water, &c.

It consists of three glass tubes of equal bore, graduated, and perforated at the bottom, the hole being covered by a disc of opal glass.

Over these tubes slide three others, which can be held in the required position by a special form of grip. The columns of liquid to be compared are adjusted to any desired weight by raising or lowering these outer tubes.

METHOD FOR THE ANALYSIS OF CATTLE FOODS.*

Hygroscopic Moisture.—Dry 2 to 3 grms. at 100° C. to constant weight.

Ash.—Char the substance at a low red heat, exhaust the charred mass with water, burn the insoluble residue, add the ash to the residue from the evaporation of the aqueous extract obtained above, dry the whole at 110°, and weigh. Determine carbonic acid and insoluble matter (sand and charcoal) in the product for the estimation of the pure ash.

Ether Extract.—Pulverise the air-dry substance till all of it will pass through a sieve with not less than $\frac{1}{60}$ inch mesh; dry about 5 grms. at 100°, and take about 2 grms. for each extraction. Exhaust with anhydrous ether of specific gravity 0·720—0·725, not less than eight hours continuously. Dry ether extract at 100° in a current of dry hydrogen to a constant weight.

Crude Protein.—Determine nitrogen by the Kjeldahl method in the manner recommended by the Nitrogen Committee, and multiply the result by 6·25 for the crude protein.

Albumenoid Nitrogen, Stutzer's Method.—Prepare cupric hydrate as follows:—Dissolve 100 grms. of pure cupric sulphate in 5 litres of water, and add 2·5 c.c. of glycerin; add dilute solution of sodium hydrate till the liquid is alkaline, filter, rub the precipitate up with water containing 5 c.c. of glycerin per litre, and then wash by decantation or filtration till the washings are no longer alkaline. Then rub the precipitate up again in a mortar with water containing 10 per cent of glycerin, thus preparing a uniform gelatinous mass that can be measured out with a pipette. Determine the quantity of cupric hydrate per 1 c.c. of this mixture.

To 1 grm. of the substance, pulverised as for the determination of the ether extract, add 100 c.c. of water in a beaker, heat to boiling, or in case of substances rich in starch heat on the water-bath ten minutes, add a quantity of the cupric hydrate mixture containing 0·7 to 0·8 grm. of the hydrate, stir thoroughly, filter when cold, wash with cold water, and without drying put the filter and its contents into the concentrated sulphuric acid for the determination of the nitrogen after Kjeldahl. For filtering use either Schleicher and Schull's No. 589 filter-paper or Swedish paper, either of which contains so little nitrogen that it can be left out of account.

If the substance examined consists of seed of any kind or residues of seeds, such as oil cake or anything rich in alkaline phosphate, add a few c.c. of a concentrated solution of alum just before adding the cupric hydrate, and mix well by stirring. This serves to decompose the alkaline phosphate, precipitating aluminum phosphate; if this is not done cupric phosphate and pure alkali may be formed, and the protein copper may be partially dissolved in this alkaline liquid.

Crude Fibre, Weende Method.—Pulverise as for the ether extract, and extract the fat, at least nearly completely. To 2 grms. of the substance in an Erlenmeyer flask add 200 c.c. of boiling 1·25 per cent sulphuric acid, boil immediately and for thirty minutes continuously with as much rotary motion as may be necessary to keep all the substances that may tend to adhere to the sides of the flask in contact with the liquid, throw on a filter of finest linen, and rinse the flask and wash the contents of the filter thoroughly with boiling water. Wash the contents of the filter back into the flask with 200 c.c. of a 1·25 per cent solution of sodium hydrate, at once raise to boiling, and boil continuously for thirty minutes with rotary motion as above described, filter through a Gooch crucible or according to some similar device, and wash very thoroughly with boiling water. Such thorough

* Official Methods of Analysis of the Association of Official Agricultural Chemists for 1887-88. U.S. Department of Agriculture, Division of Chemistry.

washing has been found to be essential to success. Wash then with alcohol and finally with ether, dry at 110°, weigh, incinerate, and give the loss of weight for crude fibre.

*Crude Fibre Closed Digestion Method.**—Pulverise as for the ether extract, and extract the fat at least nearly completely from 2 grms. of substance; allow the ether to evaporate, and transfer to a patent-stoppered beer-bottle with the aid of a funnel and 200 c.c. of a solution of 4 per cent hydrochloric acid in a wash bottle. Cork, and after seeing that the material is thoroughly saturated with the acid, with none floating on the surface, place in a bath of boiling water of such a size that the neck of the bottle being covered with a copper ring with a suitable-sized hole the entire bottle, except the upper part of the neck, will be surrounded by the boiling water or steam. At intervals of five minutes the bottle is grasped about the neck with a cloth and given such a rotary motion as to stir up the entire contents and wash down the neck. This is preferable to ordinary shaking. The digestion is continued for one hour and the acid then removed by filtration on finest washed linen, as in the preceding method, and the residue washed back with a wash-bottle into the bottle with 200 c.c. of 4 per cent solution of *sodic* hydrate, such as the granulated of the Greenbank Alkali Works. The digestion is then continued as before for one hour and the residue collected, as in the preceding method, and thoroughly washed with hot water, alcohol, and ether. It is dried at 110°, weighed, ignited at as low a heat as possible to prevent volatilisation of any soda salts which may not have been removed, and the crude fibre calculated from the loss.

Statement of Results.

	In the substance in its natural condition (or as received).	In the dry substance.
Moisture		
Ash		
Ether Extract		
Crude Fibre		
Crude Protein		
Nitrogen: Total..		
Albumenoid ..		

PRELIMINARY NOTES.

By ARTHUR MICHAEL.

The approaching close of laboratory work for the present college year finds myself and co-workers with a number of unfinished investigations. It was thought advisable to state briefly the principal results that we have obtained, before the publication of the papers in full.

I. About five years ago Bischoff and Emmert† examined the action of bromine on propenyl-tricarboxylic acid, and obtained, besides other compounds, a dibrompyrotartaric acid that is isomeric with the three acids obtained by addition of bromine to ita-, citra-, and mesaconic acids. The discoverers do not attempt to give a constitutional formula to this interesting acid; but, keeping the behaviour of malonic acid and its derivatives towards bromine in mind, there can be no doubt that the reaction is represented by the following equation:—

$$\begin{array}{l} CH_3{-}CH{-}COOH \\ \quad\;\; | \\ CH{<}^{COOH}_{COOH} \end{array} + 2Br_2 = \begin{array}{l} CH_3{-}CH{-}COOH \\ \quad\;\; | \\ CBr_2{-}COOH. \end{array}$$

This interpretation is corroborated by the fact that α-bromcrotonic acid was found among the products of the reaction:—‡

$$\begin{array}{l} CH_3{-}CH{-}COOH \\ \quad\;\; | \\ CBr_2{-}COOH \end{array} = CH_3{-}CH{-}CBr{-}COOH + HBr + CO_2.$$

This explanation of the reaction made it very probable that the third possible dibromsuccinic acid would be obtained by the action of bromine on ethenyl-tricarboxylic acid:—

$$\begin{array}{l} CH{-}(COOH)_2 \\ | \\ CH_2{-}COOH \end{array} + 2Br_2 = \begin{array}{l} CBr_2{-}COOH \\ | \\ CH_2{-}COOH \end{array} + CO_2 + 2HBr.$$

I have made a number of experiments by heating bromine and the acid in a sealed tube at 100°, and have obtained a dibromsuccinic acid which in its properties very closely resembles the symmetrical dibromsuccinic acid obtained by addition of bromine to maleic acid. However, it is extremely probable that the unsymmetrical acid would pass over into the symmetrical compound when exposed to the conditions of the experiment, and I shall repeat the experiments except that the substances will be allowed to act in the cold, which were the conditions that gave the unsymmetrical dibrompyrotartaric acid.

II. It is customary in examining the reactions of guanidine to use the carbonate, but I have found that an alcoholic solution of guanidine sulphocyanate and sodium ethylate acts as free guanidine, and gives the reactions in a much more satisfactory manner. Thus, by treating this solution in the cold with phenyl-mustard oil or benzile, the compounds described by Bamberger* and Wense† are obtained in almost theoretical yield. The solution gives reactions that cannot be realised with the carbonate. As an instance, it unites with phthalic anhydride to form the compound—

$$C_6H_4{<}^{COOH}_{CO{-}NH{-}C{-}NH}{}^{{-}NH_2}$$

which crystallises in large prisms and melts at 202°. Of greater interest is the action of cyanogen on the solution. Two compounds are formed in the reaction, one crystallising in long needles, and the other in indistinct yellow crystals that are somewhat soluble in water, giving the solution a beautiful fluorescence that is very nearly like that caused by resocyanine. The formula of this substance is $(C_1N_1O_1H_2)x$, but it is evidently of very complicated composition.‡

III. With Mr. G. M. Browne, the reactions of guanidine have been further studied. Benzoic ether and an alcoholic solution of guanidine sulphocyanate with sodium ethylate (1 mol. salt to two mols. $NaOC_2H_5$) gives no less than four distinct crystalline products. The reaction is very complicated and its study not yet completed. Guanidine sulphocyanate, sodium ethylate, and malonic ether give a substance crystallising in plates with both acid and basic properties. It has the constitution—

$$NH{=}C{<}^{NH{-}CO}_{NH{-}CO}{>}CH_2 + H_2O.$$

A. Pinner§ obtained a condensation product by the action of acetacetic ether on benzenyl-amidine, but was unsuccessful in a similar experiment with malonic ether. Such a product is obtained if an alcoholic solution of sodium malonic ether is used, and the reaction gives results with other bibasic ethers, as oxalic ether, sodium ethyloxide, and the amidine also give a condensation product.

IV. We have also continued our investigation on the isomerism of unsaturated acids. On treating solid crotonic acid, dissolved in carbon bisulphide, with chlorine at a

* Described by Clifford Richardson.
† *Berichte*, xv., 1107.
‡ *Ibid.* xiv., 616.

* *Berichte der Deutschen Chemischen Gesellschaft*, xiii., 1580.
† *Ibid*, xix., 761.
‡ While working with cyanogen it occurred to me to see whether it would react on alcoholic solutions of sodium acetacetic and sodium malonic ethers, as these substances behave like bases towards many reagents. (*American Chemical Journal*, ix., 124.) I found that a reaction takes place with great readiness, forming crystalline salts. It is my intention to have the reaction further examined.
§ *Berichte der Deutschen Chemischen Gesellschaft*, xviii., 763

low temperature, $\alpha\beta$-dichlorbutyric acid was obtained. This acid crystallises in prisms that melt at 63°. By treating the acid with alcoholic soda a fourth chlorcrotonic acid is formed, which crystallises in needles and melts at 67°. The acid differs in its properties and in its salts from the three previously known chlorcrotonic acids; and, as is evident from our previous work,* has the constitution $CH_3—CH—CCl—COOH$. It is the alpha-derivative of allocrotonic (isocrotonic) acid. We also made the observation that $\alpha\beta$-dichlorbutyric ether gives α-chlorcrotonic acid (97°) when treated with alkalies, which, in view of the fact that the free acid gives the allo-alpha-chlorcrotonic acid, is an interesting result.

V. With E. A. de Schweinitz, the action of sodium ethylate on mixtures of amides and ethers was continued. We find that urea, carbonic ether, and sodium ethylate give allophanic ether. From succinic ether, instead of carbonic, the compound—

$$\begin{array}{l} CH_2—CO—NNa—CONH_2 \\ | \\ CH_2—CO—NNa—CONH_2 \end{array}$$

was obtained. Urea sodium ethylate and benzile give—

$$\begin{array}{c} N—CONH_2 \\ \| \\ C_6H_5—CO—C—C_6H_5, \end{array}$$

and from acetamide with oxalic ether, acetyloxamic acid was obtained. Organic ethers do not react on compounds as weakly basic as metanitraniline, but a reaction takes place if sodium ethyloxide is present; with oxalic ether the compound $\begin{array}{l} CO—NHC_6H_4NO_2 \\ | \\ COOC_2H_5 \end{array}$ was obtained.

—*American Chemical Journal*, Vol. ix., No. 3.

CORRESPONDENCE.

INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir, — I do not know whether your correspondent, "F.I.C." (Chemical News, vol. lvii., p. 61), thinks that the more liberal scheme for admittance of Associates, which I propose to bring before the first meeting of the new Council, will tend to lower the standard of education required. I should like to be allowed to say that the opposite of this would be the tendency under the more liberal scheme. What we propose is, that it shall not be necessary for the Fellows of the Institute to be recruited from one or other of twenty different schools or colleges in the United Kingdom.—I am, &c.,

William Thomson.

Royal Institution Laboratory,
Manchester, February 15, 1888.

INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—The scheme which Mr. Thomson intends bringing forward at the next meeting of the new Council of the Institute of Chemistry will, I am sure, meet a want.

There are, no doubt, others who like myself studied Chemistry years ago, but who from various causes have been unable to join the Institute, and will—if compelled to study only at certain specified institutions—be probably precluded from doing so.

I went through a two years' course of theoretical and practical chemistry some ten years ago, and have since passed most of my time abroad, where I had few facilities for keeping abreast of what was going on in the chemical world at home.

After my return to England, some months ago, I communicated with the Institute to know whether, if I brushed up my knowledge of Chemistry *how and when I could*, they would be willing to subject me to the prescribed examinations.

My application was to be submitted to the Council, but in the meantime the regulations dispensing with examinations were published, and I applied for admission under them.

In reply the Secretary informed me that I was not a fit person to be admitted without examination; but as yet I have had no communication with regard to my original application.—I am, &c.,

F.C.S. since 1883.

London, February 14, 1888.

INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—On Thursday night last I received a circular, signed W. Thomson, stating that "a number of Fellows of the Institute have now agreed upon an expression of their views at the forthcoming ballot, in the manner presently to be mentioned."

The circular then proceeds to allege the existence of a "widespread feeling of dissatisfaction" as to the recent management of the Institute.

This is followed up by a general statement that the Council is too much composed of mere Professors and Teachers of Chemistry, for whom it is asserted the Institute was "*not in any way designed or required.*" The italics are mine.

The main body of the circular, containing the gist of the whole, is, however, devoted to a general complaint that the private pupils of analytical and consulting chemists are not placed, as regards admission as Associates, in the same position as those men who have passed three years in one or other of some specified schools or colleges.

To show their objection to this regulation the "number of Fellows" on whose behalf Mr. W. Thomson writes, propose that a clean sweep of eight of the officially nominated candidates for Council shall be made in favour of another list which the "number of Fellows" consider to be less professorial and teacher-like.

Mr. Thomson is careful not to let us know the names of, or assign a value to, the "number" of Fellows whom he represents; hence one is somewhat in the dark as to the true width of the widespread feelings; but they are evidently people of profound depth, for their list proves them to have been able to decide that Dr. C. R. A. Wright is less professorial than Dr. F. R. Japp, and that Mr. B. E. R. Newlands is so much more of a Professor than his brother Mr. J. A. R. Newlands, that the satisfaction of the widespread feeling demands the substitution of the latter gentleman's name for that of the former.

It is somewhat surprising, after reading the circular, to turn to the list of candidates for office proposed by the retiring Council, and to find there—(1) That the president is an analytical and consulting chemist; (2) that at least two vice-presidents belong to the same class; (3) that the treasurer is a chemical manufacturer; (4) that about seventeen out of the twenty-seven names on the council are those of analytical and consulting chemists, Mr. W. Thomson's being amongst them. Surely the most exacting analyst should be satisfied with a preponderance of this amount.

As one of the original Council, and one who had some small share in the movement which brought about the foundation of the Institute, I must enter my earnest protest against Mr. W. Thomson's attempt to caucus and capture the Council of that body. I had hoped that an

* *Berichte der Deutschen Chemischen Gesellschaft*, xix., 1378, 1386 xx., 550. *Jour. Prakt. Chemie* [2], xxxv., 257.

nterval of eleven years had permitted the jealousies which rendered chemists a divided and a helpless body to die out. We owe the Institute and its Charter to the help of the Professors of Chemistry; they have more leisure than most of us, and have not grudged it in working for the consolidation of the profession into a homogeneous whole.

I entirely traverse and deny Mr. Thomson's assertions as to the Institute not being intended for or needed by professors and teachers. The Institute was for the whole profession, and not for any class or clique. The present Council is a fair and representative body, and so is the proposed one. If an organised attack is made, as now proposed, ill feelings will be aroused all round and numerous secessions will take place.

There was a constitutional means, open to Mr. Thomson and his friends, by which they could nominate or obtain the nomination of more analysts, yet it is said that only one such form was received by the Council.

I hope that the mass of members will vote for the list as issued by the Council, and so continue the necessary work of conciliation and comprehension, thus preserving us from seeing the Institute made into a purely party trades' union, and another example of that spirit which animated him

> "Who, made for the Universe, narrowed his mind,
> And to Party gave up what was meant for Mankind.'

—I am, &c.,

R. J. Friswell.

115, Darenth Road, N., February 18, 1888.

[We have good reasons for knowing that Mr. W. Thomson stated at a meeting of the Council of the Institute of Chemistry that the circular above referred to, although purporting to be signed by him, had been issued without his authority.—*Ed.* C. N.]

INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—With reference to a circular letter dated the 12th inst., and bearing the signature of Mr. W. Thomson, which has been sent to the Fellows of the Institute of Chemistry, we beg that you will be so good as to allow us to inform the Fellows, through your columns, that we have not been consulted in regard to the action taken by Mr. Thomson, and that we decline to offer ourselves as candidates for election in opposition to the nominations of the Council,—We are, &c.,

Boverton Redwood.
Alfred Gordon Salamon.

London, February 20, 1888.

INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—I have received a circular relating to the Institute of Chemistry, dated the 14th inst., and issued from the Royal Institution, Manchester, in which my name has been inserted as a candidate for the Council of the Institute without my knowledge or consent.

Now although, in common with other Fellows of the Institute, I have long since expressed a qualified agreement with certain alterations in the mode of carrying out its objects, it need hardly be said that I in no way approve of the changes in the Council proposed by the Manchester circular, and I intend voting for the Balloting List as issued by the Council.

Having personally no desire or valid claim to be on the Council, should I by any chance be elected I would at once decline to serve and send in my resignation.—I am, &c.,

John A. R. Newlands.

27, Mincing Lane, London, E.C., February 20, 1888.

INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—I shall be obliged if you will allow me, through your columns, to state that I was entirely unaware that my name was to be proposed, in opposition to the nomination of the Council of the Institute of Chemistry. I was not consulted in the matter at all.—I am &c.,

E. W. Voelcker.

11, Salisbury Square, Fleet Street, London, E.C., Feb. 21, 1888.

COLOUR OF BRICKS.

To the Editor of the Chemical News.

Sir,—Can the readers of the Chemical News give information on the connection between the chemical composition of clay and the colour of the bricks manufactured from it?

Muspratt's "Chemistry" gives a tabular outline of the analyses of clays and the corresponding colour of the bricks.

In this neighbourhood there is a brick-field in which there are three distinct kinds of clay, each of which produces red bricks, but in each case the bricks become grey when sprinkled with road-sand before baking. The road-sand is ground flint or impure silica and the bricks sometimes are red in the centre; the greyness is caused entirely by the sand.

The question to which an answer is wanted is—How does the sand alter the colour of the bricks?—I am, &c.

Piffard.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 5, January 30, 1888.

Researches on Ruthenium: Per-ruthenic Acid.—H. Debray and A. Joly.—The authors describe the preparation and purification of this acid. It melts at 25·5°, forming a deep orange-red liquid which solidifies very slowly. The solid product retains the vitreous state for a long time. It only crystallises well on sublimation. Its vapour density is 5·77. It dissolves slowly in water, but does not appear to form a definite hydrate. The solution, in the absence of chlorine and of hypochlorites, is stable for some time in the dark or in diffused light. It ultimately becomes turbid and deposits on the sides of the vessel a black coating which is a hydrated ruthenium sesquioxide.

On Cinchonigine.—E. Jungfleisch and E. Léger.—The composition of this new base, which is possibly identical with that isolated by MM. Caventon and Girard in their recent attempt to fix C_2O_2 upon cinchonine has the composition $C_{28}H_{22}N_2O_2$. It forms colourless prisms of high refractive power. It melts at 128° and is volatile distilling under reduced pressure. It is very sparingly soluble in ethylic, methylic, and amylic alcohol, chloroform, benzene, and acetone. It is less soluble in anhydrous ether. Its acid solutions are not fluorescent. Its solution in water blues red litmus, but it has no action upon phenolphthalein.

On Bases obtained from Liquids which have undergone the Alcoholic Fermentation.—E. Charles Morin.—The author has determined the composition of one of these bases, $C_7H_{10}N_2$. He has studied some of the reactions of this base, and finds that it gives a yellow

precipitate with potassium iodo-mercurate. This precipitate is at first voluminous, but it soon changes into large yellow needles, which are very characteristic. With mercuric chloride and with phosphotungstic acid it gives white precipitates and a yellow deposit with phosphomolybdic acid.

The Laws of Chemical Equilibrium.—H. Le Chatelier.—A mathematical paper, not susceptible of useful abstraction.

Zeitschrift fur Analytische Chemie.
Vol. xxvi., Part 3.

Iodometric Studies.—G. Topf.—A completion of the extensive treatise begun in Part 2 of the present volume.

Determination of Ammonia in Soils by the Azotometric Method.— Dr. Anton Baumann.— In a former memoir the author has shown that this method suffers from three serious defects. These errors he now explains in detail. He fully admits that in the determination of pure ammoniacal salts the azotometric method is at once expeditious and accurate. But for the analysis of soils it should be entirely rejected.

The Analysis of Explosives.—W. Hempel.— This paper is unintelligible without the accompanying illustration.

Reichert's Method of Butter Analysis.— H. B. Cornwall and Shippen Wallace.— From the "Report of the State Board of Health of New Jersey."

The Quantitative Determination of the Constituents of Milk.—R. Palm.—The author maintains that none of the published methods for the quantitative determination of the constituents of milk satisfies the present demands of science. The determination of fat in milk gives no accurate results, the fatty matter coming up invariably too large. The lactose is always given too high, since, after the removal of the albumen and caseine from the milk, the other proteines, especially hemi-albumose and milk-peptone, reduce Fehling's liquor exactly like milk sugar. Hence these proteines, according to the present method, is calculated as lactose. The total proteins, from the same reason, are given too low. The author recommends the determination of the albumenoids either with a solution of mercury oxide, according to Millon and Commaille, or by means of a solution of tannin. In the latter case the protein tannate is perfectly dried and then treated with a mixture of three parts by weight of ether to one part of absolute alcohol. This mixture extracts all the tannin.

Quantitative Determination of Mineral Oils in Saponifiable Fats of Animal or Vegetable Origin.—A. Gawalowski.—The author saponifies with an alcoholic solution of potassa (about 2 parts potassa to 10 parts of fat), boils off the bulk of the alcohol, adds a solution of calcium or sodium chloride, and then sodium dicarbonate until the alkaline reaction has about disappeared. The soap thus treated is quite insoluble in petroleum-ether, and the mineral oil dissolved out is entirely free from soap.

Double Aspirator.—Hugo Schiff and C. Marangoni.

Complete Titration - Apparatus for Determining Acid in Distiller's Mashes.—F. Larssen.

Apparatus for the Volumetric Determination of Carbonic Acid in Carbonates.— D. Sidersky.— These three papers all require the accompanying illustrations,

Convenient Method of Generating Pure (Non-arsenical) Sulphuretted Hydrogen.—Dr. R. Fresenius.—Four parts of calcium sulphide are well ground up with one part of burnt calcium sulphate, water is added enough to form a very thick paste, which is then placed in flat quadrangular capsules, levelled down with a porcelain pestle, and allowed to set. The discs, taken out of the capsules, and about 15 m.m. in thickness, are cut up whilst still moist in cubes and dried at a gentle heat. For use the matter is placed in a Kipp gas generator and treated with dilute hydrochloric acid (1 vol. acid at sp. gr. 1·12 and 1 vol. water). The sulphuretted hydrogen is given off easily and steadily.

Micro-chemical Analysis.— T. H. Behrens.— From *Receuil des Travaux Chimiques des Pays-Bas* and Chemical News.

Determination of the Specific Gravity of Liquids.—C. Bohn.—The author utilises the principle of measuring the heights of columns of liquids which exert an equal pressure.

Determination of Melting-points.—C. F. Roth.—The author has proposed an apparatus which furnishes at at once corrected values, *i.e.*, values in which it is considered that for accurate determinations the total thread of mercury must be heated to the temperature of the melting substance. The apparatus is a modification of that of Anschütz and Schulz.

The Application of Steam in Chemical Laboratories.—R. Galloway and J. O'Farrel.—From the *Philosophical Magazine*.

Apparatus for Determining Carbonic Acid in Carbonates.—R. Baur.—An unimportant modification of an instrument previously described in the *Zeitschrift* (xxiii., p. 371).

Apparatus for Determining Tensions.—G. W. A. Kahlbaum.

New Mercurial Air-pump.—Greiner and Friedrichs.—These two papers are merely mentioned.

Thermo-regulators.—G. H. Bailey.—From the Chemical News.

Special Forms of Condensers.—J. Walter, Shenstone, Kreusler, Wollny, and C. B. Gibson.— Modifications of apparatus formerly described in the *Zeitschrift* and a novel device from the *Analyst*.

Gas-Generator.—A. Gawalowski.—In this apparatus, unlike that of Kipp, the acid is completely utilised. Much more attention is required.

Exsiccator Tube for Boats.—A. Gawalowski.—This device cannot be intelligibly described without the accompanying illustration.

Improved Filter Stand.— Carl Simon (*Chemiker Zeitung*).—The funnels are supported in a porcelain arm having three ribs projecting inwards.

New Burette Stand.— L. Weinstein (*Chemiker Zeitung*).—A description of this apparatus would be of little utility.

The Use of Normal Ammonia Liquids.—R. Hempel.—The author particularly recommends a semi-normal ammonia liquid.

Original Standard for Volumetry.—R. Ullbricht and E. Meissl. — The authors recommend potassium tetroxalate, which is neither efflorescent nor hygroscopic, and is easily obtained in a state of purity. They prepare a hot saturated solution of neutral potassium oxalate and add the calculated quantity of a hot saturated solution of oxalic acid. On cooling the tetra-oxalate crystallises out and can be obtained perfectly pure by repeated crystallisation from hot water, cooling rapidly. If the liquid is stirred whilst cooling we obtain small crystals free from mother-liquor. The salt is then dried by exposure on blotting-paper. It serves not merely for the standard in acidimetric and alkalimetric determinations, but also for permanganate solutions.

Recovery of Molybdenum Residues.—W. Venator (*Chemiker Zeitung*).—The author tests first if the residues contain iron, and adds, if needful, ferric chloride until the liquid has a brownish yellow colour. For separating out the phosphoric acid he adds ammonia, when all the phosphoric acid is precipitated as iron phosphate along with excess of iron and a part of the magnesia. The pre-

cipitate is filtered off and the filtrate mixed with barium chloride, when the molybdic acid and any sulphuric acid present are precipitated as barium salts. The precipitate is well washed with hot water, dried, and digested with the suitable quantity of ammonium sulphate. The barium sulphate is filtered off and the ammonium sulphate separated by crystallisation from the ammonium molybdate. Residues containing much ammonium citrate (Wagner's method) interfere with the methods for recovery, and should not be mixed with other molybdic residues.

Thickened Filter-paper.—E. E. H. Francis.—From the *Journal of the Chemical Society.*

Generating Chlorine Gas.—C. Winckler.—The author makes small cubes of a mixture of chloride of lime and burnt calcium sulphate, and treats them in a Kipp apparatus with hydrochloric acid at sp. gr. 1·124, mixed with an equal volume of water. No sulphuric acid must be present.

Separation of Soda and Potassa from Lithia by treating the Chlorides with Amylic Alcohol, and a Similar Separation of the Same Alkalies from Magnesia and Lime.—F. A. Gooch.—From *Proceedings of American Academy of Arts and Sciences.*

On Germanium, its Detection and Determination.—Clemens Winckler.—Noticed under *Journal fur Praktische Chemie.*

Determination of Boric Acid.—F. A. Gooch.—From *Proceedings of American Academy of Arts and Sciences.*

Sugar obtained from Agar-Agar.—R. W. Bauer.—The author furnishes further proof of the non-identity of arabinose and lactose. Agar-agar contains a carbohydrate not yet isolated, but nearly related to Muntz's galaktin. On boiling with dilute acids it passes into lactose.

Two New Reactions for Sugar.—Hans Molisch.—Already noticed.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Vinegar-Making Apparatus.—Does any correspondent know of a vinegar-making apparatus, capable of making a medium vinegar in twelve to fourteen days? It is desired to make 300 or 400 gallons in this time.—W.

MEETINGS FOR THE WEEK.

Monday, 27th.—Medical, 8.30.
— Society of Arts, 8. "The Modern Microscope," by John Mayall, Jun.
Tuesday, 28th.—Institution of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Royal Institution, 3. "Before and After Darwin," by George John Romanes, F.R.S.
Wednesday, 29th.—Society of Arts, 8. Discussion on Mr. Swire Smith's paper, "The Technical Education Bill."
— Geological, 8,
Thursday, March 1st.—Royal, 4.30.
— Royal Institution 3. "Early Secular Choral Music," by Prof. Hubert H. Parry, M.A.
— Parkes Museum, 5. "Milk and Disease," by G. Sims Woodhead, M.D. (Edin.), F.R.S.E.
— Chemical, 8. "The Origin of Colour and the Constitution of Colouring-matter generally," by H. E. Armstrong, F.R.S.
Friday, 2nd.—Geologists' Association, 8.
— Royal Institution, 9. "Poisons and Poisoning," by C. Meymott Tidy, M.B., F.C.S.
Saturday, 3rd.—Royal Institution, 3. "Experimental Optics," by the Right Hon. Lord Rayleigh.

Errata.—P. 64, col. i., line 30 from top, *for* "Gumdagai" *read* "Gundagai." Line 34, *for* "thin surfaces" *read* "their surfaces." Line 39, *for* "firmness" *read* "fineness." Col. 2 line 31 from top, *for* "wasting" *read* "roasting."

Chemist Wanted; one understanding Preparation of Coal-Tar Products, Aniline, &c., preferred.—Address' stating salary expected and giving references as to experience and character, Box 444, Chemical News Office, Boy Court, Ludgate Hill, London, E.C.

Wanted, 600 tons Crude Pressed (hot or cold) Naphthaline per annum. Contracts would be made for the whole or for smaller quantities.—Address, in first instance, William Fox, 4, Great Tower Street, London, E.C.

For Sale.—Long-beam Assay Balance, by Wolters, nearly new. Will carry 400 grains in each pan, and turn to 1-1000th of a grain. Gold-plated pans, agate edges and planes. Cost 12 guineas; will sell for £8.—Apply to Lees and Sanders, Assayers, Smelters, and Refiners of Gold, Silver, and Platinum, 5 and 6, Warstone Lane, Birmingham.

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To be Sold, by Tender, a Part of the Valuable Machinery and Tar Distilling Plant, Tools, and Effects, at the Naphtha, Creosote, and Patent Coke Works, West Bromwich, comprising—Double-acting Slide-valve STEAM PUMP, 5-inch cylinder, 2½-inch ram; "Reliable" Slide-valve TAR PUMP, with 8-inch steam cylinder, 6-inch ram (Evans, Wolverhampton); Hydraulic Force-Pumps; pair of Contractors' Single-acting Lift-Pumps; 12-inch Single-acting Air Force-Pump, 18-inch stroke; Hydraulic Force-Pumps; three HYDRAULIC PRESSES; three sets of FILTER PRESSES; Hydraulic Pressure-Pumps; Crushing Mill; Vertical Drilling Machine; Foot-Lathe; new Steam Boiler; nine Wrought-iron STORE BOILERS and TANKS; Express "Extincteur" Fire-Engines; Derrick Crane, on carriage; Platform Weighing-machine; Bourdon Pressure-gauge, to indicate 3 tons per inch; Cast-iron Furnace-Boilers; Wheelbarrows; Gasfitters' Stocks and Dies; Carpenters', Smiths'. and other Tools; Wrought-iron Scrap; Office Furniture; two Iron Safes; and a variety of other effects.

Catalogues and Conditions of Sale may be obtained of the Trustee, HENRY BISHOP, Esq., 41, Coleman Street, London, E.C.; Messrs. JOSEPH COOKSEY and SON, Auctioneers, West Bromwich; or at the Works.

N.B. Tenders of the whole or any part must be delivered to the Trustee on or before Thursday, the 1st of March.

The Vendors do not bind themselves to accept the highest or any offer.

ELECTRIC LIGHT.

An Improved Automatic System. Any indifferently governed Engine will give quite steady lights. All kinds of Electrical Apparatus.

J. G. STATTER and CO., Limited,
Alliance Engineering Works, West Drayton, near London.

PATENTS, DESIGNS, & TRADE MARKS ACT, 1883.

In the matter of Letters Patent granted to Arthur Favier, of Paris, France, 15, Rue de Richelieu, for "Improvements in the manufacture of explosives and in cartridges containing such improved explosives," dated 16th February, 1885, No. 2139.

Notice is hereby given that the said A. Favier has applied for leave to amend the specification numbered as above.

A copy of the Specification as proposed to be amended can be inspected at the Patent Office, and full particulars of the proposed amendment were set forth in the Official Journal of the Patent Office issued on the 18th of February, 1888.

Any person intending to oppose the said application must leave particulars of his objections thereto (on Form G) at the Patent Office, 25, Southampton Buildings, London, W.C., within one calendar month from the date hereof.

Dated this 18th day of February, 1888.

(Signed) H. READER LACK,
Comptroller-General.

W. P. THOMPSON AND BOULT, Agents,
323, High Holborn, W.C.

THE CHEMICAL NEWS.

Vol. LVII. No. 1475.

NOTE ON THE DETECTION OF ACETIC ACID IN PRESENCE OF MORPHINE.

By G. STILLINGFLEET JOHNSON, King's College, London.

Having frequently been consulted by laboratory students as to the best means of detecting the acetic radicle in morphine acetate, I have reason to believe that the method described below will prove useful to practical chemists. The aqueous solution of morphine acetate is treated with a solution of ferric chloride, both solutions being free from excess of acid. The morphine blue is at once developed, and gives rise to a deep green tint, if the ferric chloride be in large excess.

On warming the colour is changed to blood-red, due to the ferric acetate, which remains stable after the disappearance of the morphine blue.

The following experiment proves that 1 part by weight of morphine acetate dissolved in 870 parts of water gives a very decided reaction.

0·069 grm. of morphine acetate dissolved in 60 c.c. water.

Added 0·0725 grm. of $Fe_2Cl_6.2Aq$ dissolved in 10 c.c. water.

Heat applied with a thermometer in the mixture.

Up to 40° C. the morphine blue became deeper and deeper in tint, but began to fade at 60° C., and had completely disappeared at 80° C., the liquid having now a deep blood-red colour, which remained unchanged after boiling for five minutes. No basic ferric acetate was precipitated.

It is advantageous to be able to detect both base and acid by means of the same reagent.

A slight reddish tint is developed when morphine is dissolved in a neutral solution of ferric chloride and the temperature raised to 100° C., but this reaction is not of a kind to mislead one in the search for acetic acid.

THE DETERMINATION OF VANADIUM IN THE PRESENCE OF CHROMIUM, ALUMINIUM, AND PHOSPHORUS.

At the meeting of the Newcastle Section of the Society of Chemical Industry, February 8th, 1888, C. W. Ridsdale, F.I.C., F.C.S., read a paper on the above subject. Investigations as to the constitution of basic converter slag* had rendered an enquiry into the value of published methods imperative. The methods examined were—

1. By precipitation as vanadate of ammonia from ammonia extract or other alkaline solution.
2. By precipitation as lead or barium salts, and subsequent decomposition by nitric and sulphuric acids.
3. By colorimetric methods.
4. By titration with permanganate of potash, and analogous methods.
5. By Lindemann's method of titration with ferrous sulphate.

The various difficulties and sources of error were pointed out, and the fifth method shown to be at present the most useful and reliable. An outline for complete analysis of converter slags, &c., in conjunction with the last-named method, was described, and data were furnished as to the effect of vanadium on the precipitation of phosphoric acid, whether as phospho-molybdate of ammonia or ammonio-phosphate of magnesia, and on alumina and chromium sesquioxide.

* *Iron and Steel Inst. Journ.*, vol. i., 1887.

METHODS OF ANALYSES OF DAIRY PRODUCTS.*

Butter.

Microscopic Examination.

Place a small portion of the fresh sample, taken from the inside of the mass, on a slide; add a drop of pure sweet oil, cover with gentle pressure, and examine with a ½ to ⅛ inch objective for crystals of lard, &c.

Examine same specimen with polarised light and selenite plate.

Pure fresh butter will neither show crystals nor a parti-coloured field with selenite. Other fats, melted and cooled and mixed with butter, will usually present crystals and variegated colours with the selenite plate.

Specific Gravity.

Take a specific gravity flask, not graduated, the stopper of which carries a delicate thermometer, whose bulb occupies sensibly the centre of the flask. The thermometer should be first compared with a standard instrument.

Clean the picnometer with water, alcohol, and ether; dry, be careful to remove all the ether vapour, and weigh.

Fill with distilled water, insert stopper, and place in vessel containing water which comes nearly to top of picnometer (without stopper); gradually raise the temperature of water in vessel containing flask until it is 40·5° to 41° C.

The moment the thermometer of the picnometer marks 40° remove the flask, dry carefully, cover capillary safety-tube, and set in balance or desiccator to cool. Weigh when temperature falls nearly to that of balance room. Having determined the titre of the flask it is to be carefully dried, filled with the melted and filtered fat at a temperature below 40°, and the weight of the fat determined at 40°, as directed above.

Melting-Point.

Apparatus.—The apparatus, Fig. 1, consists of (1) an accurate thermometer, for reading easily tenths of a degree; (2) a less accurate thermometer, for measuring the temperature of water in the large beaker glass; (3) a tall beaker glass, 35 c.m. high and 10 c.m. in diameter; (4) a test-tube 30 c.m. high and 3·5 c.m. in diameter; (5) a stand for supporting the apparatus; (6) some method of stirring the water in the beaker,—for example, a blowing bulb of rubber and a bent glass tube extending to near the bottom of the beaker; (7) a mixture of alcohol and water of the same specific gravity as the fat to be examined.

Manipulation.—The disks of the fat are prepared as follows:—The melted and filtered fat is allowed to fall from a dropping tube from a height of 15 to 20 c.m. on to a smooth piece of ice floating in water. The disks thus formed are from 1 to 1½ c.m. in diameter, and weigh about 200 m.grms. By pressing the ice under the water the disks are made to float on the surface, whence they are easily removed with a steel spatula.

The mixture of alcohol and water is prepared by boiling distilled water and 95 per cent alcohol for ten minutes, to remove the gases which they may hold in solution. While still hot, the water is poured into the test-tube already described until it is nearly half full. The test-tube is then filled with the hot alcohol. It should be

* Official Methods of Analysis of the Association of Official Agricultural Chemists for 1887-88. U.S. Department of Agriculture, Division of Chemistry.

poured in gently down the side of the inclined tube to avoid too much mixing. If the tube is not filled until the water has cooled, the mixture will contain so many air bubbles as to be unfit for use. These bubbles will gather on the disk of fat as the temperature rises, and finally force it to the top of the mixture.

The test-tube containing the alcohol and water is placed in a vessel containing cold water, and the whole cooled to below 10° C. The disk of fat is dropped into the tube from the spatula, and at once sinks until it reaches a part

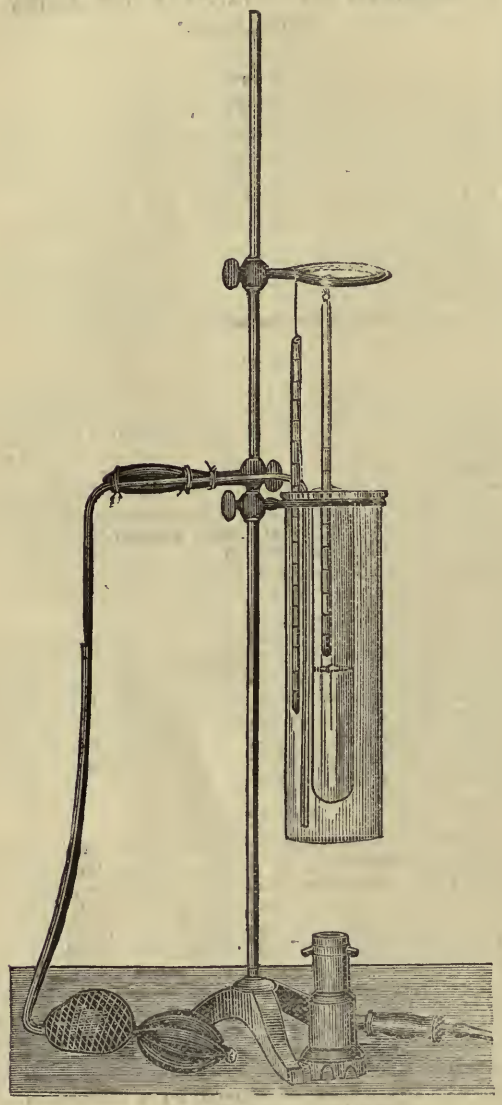

FIG. 1.

of the tube where the density of the alcohol water is exactly equivalent to its own. Here it remains at rest, and free from the action of any force save that inherent in its own molecules.

The delicate thermometer is placed in the test-tube, and lowered until the bulb is just above the disk. In order to secure an even temperature in all parts of the alcohol mixture in the vicinity of the disk, the thermometer is moved from time to time in a circularly pendulous manner. A tube prepared in this way will be suitable for use for several days,—in fact until the air bubbles begin to attach themselves to the disk of fat. In no case did the two liquids become so thoroughly mixed as to lose the property of holding the disk at a fixed point, even when they were kept for several weeks.

In practice, owing to the absorption of air, it has been found necessary to prepare new solutions every third or fourth day.

The disk having been placed in position, the water in the beaker glass is slowly heated, and kept constantly stirred by means of the blowing apparatus already described.

When the temperature of the alcohol water mixture rises to about 6° below the melting-point, the disk of fat begins to shrivel, and gradually rolls up into an irregular mass.

The thermometer is now lowered until the fat particle is even with the centre of the bulb. The bulb of the thermometer should be small, so as to indicate only the temperature of the mixture near the fat. A gentle rotary movement should be given to the thermometer bulb, which might be done with a kind of clockwork. The rise of temperature should be so regulated that the last ·2° of increment require about ten minutes. The mass of fat gradually approaches the form of a sphere, and when it is sensibly so the reading of the thermometer is to be made. As soon as the temperature is taken, the test-tube is removed from the bath and placed again in the cooler. A second tube, containing alcohol and water, is at once placed in the bath. It is not necessary to cool the water in the bath. The test-tube (ice water being used as a cooler) is of low enough temperature to cool the bath sufficiently. After the first determination, which should be only a trial, the temperature of the bath should be so regulated as to reach a maximum about 1·5° above the melting-point of the fat under examination.

Working thus with two tubes, about three determinations can be made in an hour.

After the test-tube has been cooled the globule of fat is removed with a small spoon attached to a wire, before another disk of fat is put in.

Volatile Acids.

Take about 2·5 grms. filtered fat in 200 c.c. flask, to be used in subsequent distillation; add 2 c.c. aqueous solution potassium hydrate, containing 0·5 grm. KOH per c.c. Add 2 c.c. 95 per cent alcohol, and heat on water-bath, with occasional agitation. Saponification is complete in a few minutes. Evaporate until alcohol is all driven off, using a current of air to remove alcoholic vapour. The flask is fitted with a delivery tube and condenser, as in Fig. 2. The delivery tube is carried up about 8 inches before it is bent to enter the condenser, and a bulb is blown in it just below the elbow, and this is filled with broken glass or glass-wool.

The fatty acids are then set free with 20 c.c. of a solution of phosphoric acid, made by dissolving 200 grms. glacial phosphoric acid in water and making up to 1 litre. Enough water is added to make the volume of liquid in the flask 70 c.c. Distillation is continued until the distillate measures 50 c.c., which is titrated with—

$$\frac{N}{10}\ NaOH,$$

using phenol-phthalein as indicator.

(Care should be taken to have the potash used free from carbonate. A potash containing carbonate saponifies a a fat with great difficulty, In an instance where the saponification was taking place very slowly, the potash was found to contain 6·80 per cent CO_2, equal to 21·17 per cent K_2CO_3.)

Soluble Acids.

The washings obtained in the process of estimating the insoluble acids, the description of which follows, are made up to 1 litre and an aliquot part taken for titration with one-tenth N alkali, using phenol phthalein as indicator.

Method for the Determination of Soluble and Insoluble Acids.

Reagents.

1. A standard semi-normal hydrochloric acid solution, accurately prepared.

2. A standard decinormal soda solution, accurately prepared; each 1 c.c. contains 0·0040 grm. of NaOH and neutralises 0·0088 grm. of butyric acid, $C_4H_8O_2$.

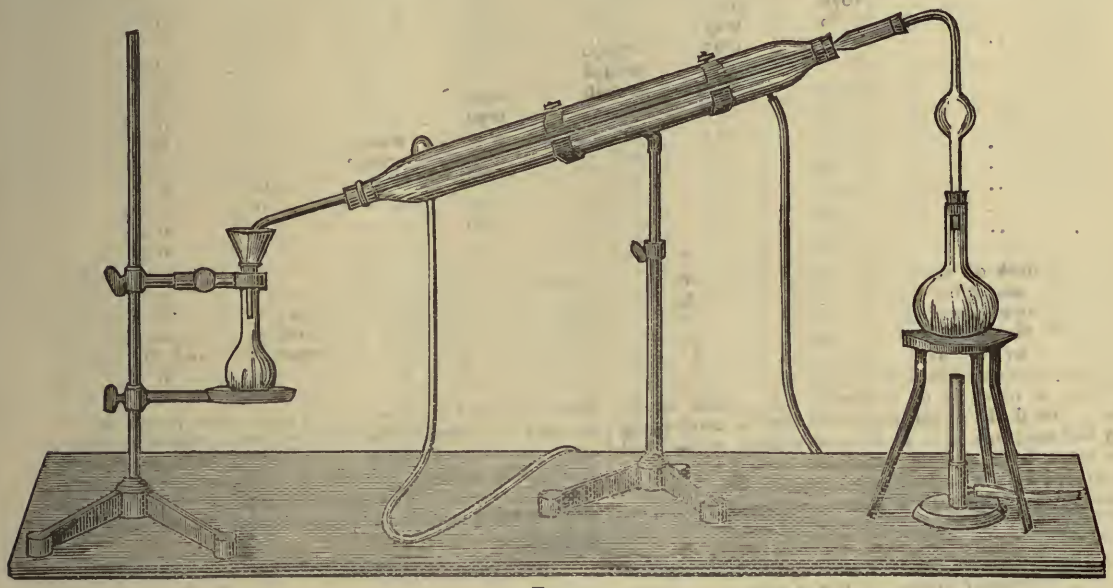

Fig. 2.

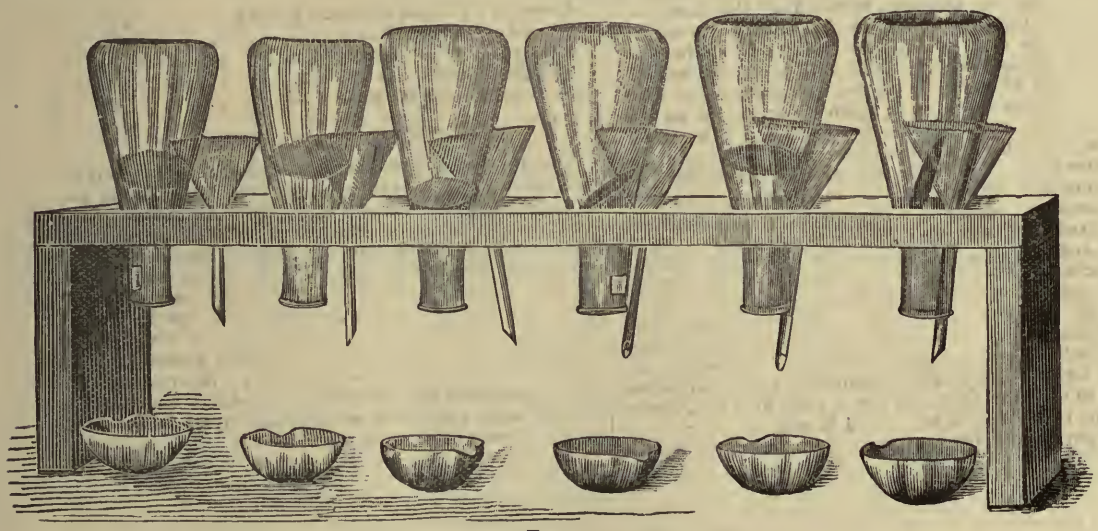

Fig. 3.

3. An approximately semi-normal alcoholic potash. Dissolve 40 grms. of good stick potash in 1 litre of 95 per cent alcohol, re-distilled. The solution must be clear, and the KOH free from carbonates

4. A 1 per cent solution of phenol-phthalein in 95 per cent alcohol.

Saponification is carried out in rubber-stoppered beer-bottles holding about 250 c.c.

About 5 grms. of the melted butter fat, filtered and freed from water and salt, are weighed out by means of a small pipette and beaker, which are re-weighed after the sample has been taken out, and run into a saponification bottle; 50 c.c. of the semi-normal potash are added, the bottle closed, and placed on the steam-bath until the contents are entirely saponified, facilitating the operation by occasional agitation. The alcoholic potash is measured always in the same pipette, and uniformity further insured by always allowing it to drain the same length of time, viz., 30 seconds. Two or three blanks are also measured out at the same time, and treated in the same way.

In from five to thirty minutes, according to the nature of the fat, the liquid will appear perfectly homogeneous, and when this is the case the saponification is complete, and the bottle may be removed and cooled. When sufficiently cool the stopper is removed, and the contents of the flask rinsed with a little 95 per cent alcohol into

Table for the Calculation of Soluble Fatty Acids.

No. c.c. KOH sol.	Equiv. Grms.	N/10 NaOH.	Equiv. Grms.	N/10 NaOH.	Equiv. Grms.	N/10 NaOH.	Equiv. Grms.
10	0·088	+ 0·25	0·0902	+ 0·50	0·0924	+ 0·75	0·0946
11	0·0968	0·25	0·0990	0·50	0·1012	0·75	0·1034
12	0·1056	0·25	0·1078	0·50	0·1100	0·75	0·1122
13	0·1144	0·25	0·1166	0·50	0·1188	0·75	0·1210
14	0·1232	0·25	0·1254	0·50	0·1276	0·75	0·1298
15	0·1320	0·25	0·1342	0·50	0·1364	0·75	0·1386
16	0·1408	0·25	0·1430	0·50	0·1452	0·75	0·1474
17	0·1496	0·25	0·1518	0·50	0·1540	0·75	0·1562
18	0·1584	0·25	0·1606	0·50	0·1628	0·75	0·1650
19	0·1672	0·25	0·1694	0·50	0·1716	0·75	0·1738
20	0·1760	0·25	0·1782	0·50	0·1804	0·75	0·1826
21	0·1848	0·25	0·1870	0·50	0·1892	0·75	0·1914
22	0·1936	0·25	0·1958	0·50	0·1980	0·75	0·2002
23	0·2024	0·25	0·2046	0·50	0·2068	0·75	0·2090
24	0·2112	0·25	0·2134	0·50	0·2156	0·75	0·2178
25	0·2200	0·25	0·2222	0·50	0·2244	0·75	0·2266
26	0·2288	0·25	0·2310	0·50	0·2332	0·75	0·2354
27	0·2376	0·25	0·2398	0·50	0·2420	0·75	0·2442
28	0·2464	0·25	0·2486	0·50	0·2508	0·75	0·2530
29	0·2552	0·25	0·2574	0·50	0·2596	0·75	0·2618
30	0·2640	0·25	0·2662	0·50	0 2684	0·75	0·2706

Erlenmeyer flask of about 250 c.c. capacity, which is placed on the steam-bath, together with the blanks, until the alcohol has evaporated.

Titrate the blanks with semi-normal HCl, using phenolphthalein as an indicator. Then run into each of the flasks containing the fat acids 1 c.c. more semi-normal HCl than is required to neutralise the potash in the blanks. The flask is then connected with a condensing tube 3 feet long, made of small glass tubing, and placed on the steam-bath until the separated fatty acids form a clear stratum on the surface of the liquid. The flask and contents are then allowed to become thoroughly cold, ice water being used for cooling.

The fatty acids having quite solidified, the contents of the flask are filtered through a dry filter-paper into a litre flask, in the manner shown in Fig. 3, care being taken not to break the cake: 200 to 300 c.c. of hot water is next poured on the contents of the flask, the cork with its condenser tube re-inserted, and heated on the steam-bath until the cake of acids is thoroughly melted, the flask being occasionally agitated with a circular motion, so that none of its contents are brought on the cork. When the fatty acids have again separated as an oily layer, the flask and its contents are cooled in ice water, and the liquid filtered through the same filter into the same litre flask. This treatment with hot water, followed by cooling and filtration of the wash water, is repeated three times, the washings being added to the first filtrate. The mixed washings and filtrate are next made up to 1 litre, and 100 c.c., in duplicate, is taken and titrated with decinormal NaOH. The volume required is calculated to the whole liquid. The number so obtained represents the measure of decinormal NaOH neutralised by the soluble fatty acids of the butter fat taken, plus that corresponding to the excess of the standard used, viz., 1 c.c. The amount of soda employed for the neutralisation is to be diminished, for the 1 litre, by 5 c.c., corresponding to the excess of 1 c.c. ½ N acid.

This corrected volume, multiplied by the factor 0·0088, gives the butyric acid in the weight of butter fat employed. (See Table.)

The flask containing the cake of insoluble fat acids is inverted and allowed to drain and dry for twelve hours (Fig. 3), together with the filter-paper through which its soluble fatty acids have been filtered. When dry the cake is broken up and transferred to a weighed glass evaporating dish. Remove from the dried filter-paper as much of the adhering fat acids as possible and add them to the contents of the dish. The funnel, with the filter-paper, is then placed in an Erlenmeyer flask, a hole is made in the bottom of the filter-paper, and it is thoroughly washed with absolute alcohol from a wash-bottle. The flask is rinsed with the washings from the filter-paper and pure alcohol, and these transferred to the evaporating dish. The dish is placed on the steam bath and the alcohol driven off. It is then transferred to the air-bath and dried at 100° C. for two hours, taken out, cooled in a desiccator, and weighed. It is then again placed in the air-bath and dried for another two hours, cooled as before, and weighed. If there is no considerable decrease in weight the first weight will do; otherwise, re-heat two hours and weigh. This gives the weight of insoluble fat acids in the quantity taken, from which the percentage is easily calculated.

The table gives the weight of soluble fatty acids (butyric, &c.) for each quarter of a c.c. of decinormal alkali from 10 to 30.

Example: Weight fat taken (grms.)	4·967
No. c.c. N/10 alkali used	25·50
Less 5 c.c. due to 1 c.c. N/2 acid	20 50
Weight soluble fat acids	0·1804
Per cent soluble fat acids	3·63

Saponification Equivalent.

About 2·5 grms. butter fat (filtered and free from water) are weighed into a patent rubber-stoppered bottle and 25 c.c. approximately semi-normal alcoholic potash added. The exact amount taken is determined by weighing a small pipette with the beaker of fat, running the fat into the bottle from the pipette and weighing beaker and pipette again. The alcoholic potash is measured always in the same pipette, and uniformity further insured by always allowing it to drain the same length of time (thirty seconds). The bottle is then placed in a steam-bath together with a blank containing no fat. After saponification is complete, and the bottles cooled, the contents are titrated with accurately semi-normal hydrochloric acid, using phenol-phthalein as an indicator. The number of c.c. of the acid used for the sample deducted from the number required for the blank gives the number of c.c. which combines with the fat, and the saponification equivalent is calculated by the following formula, in which W equals the weight of fat taken in m.grms. and N the number of c.c. which has combined with the fat.

$$\text{Sap. Equiv.} = \frac{2W}{\quad}.$$

If it is desirable to express the number of m.grms. of potash for each grm. of fat employed it can be done by dividing 5·610 by the saponification equivalent and multiplying the quotient by ten.

Water.

Place about 2 grms. in flat-bottomed platinum dish two-thirds full of clean, dry sand, and heat for two hours in air-bath at 105° C. (For alternate method of estimation of water see article on "Methods of Milk Analysis," to be inserted hereafter).

Estimation of Salt.

Volumetric Method.—The amount of the butter or butter substitute to be taken is 5 to 10 grms.; weigh in a counterpoised beaker-glass. The butter (fresh from the refrigerator) is placed in portions of about 1 grm. at a time in the beaker, these portions being taken from different parts of the sample. By this means a reasonably fair sample of the whole is obtained.

The given quantity having been weighed out, it is removed from the pan.

Hot water is now added (about 20 c.c.) to the beaker containing the butter, and after it has melted the liquid is poured into the bulb of the separating apparatus (Fig. 4).

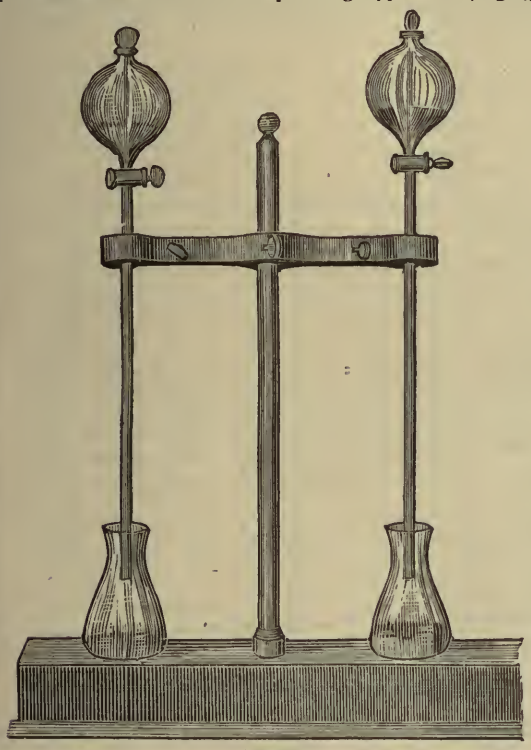

Fig. 4.

The stopper is now inserted and the contents shaken for a few moments.

After standing until the fat has all collected on top of the water, the stopcock is opened and the water, containing most of the salt, is allowed to run into an Erlenmeyer flask, being careful to let none of the fat globules pass.

Hot water is again added to the beaker and thence poured into the separatory apparatus, the bottle well shaken, and the foregoing process is repeated ten to fifteen times, using each time 10 to 20 c.c. water.

The resulting washings contain all but a mere trace of the NaCl, originally present in the butter.

Estimation of NaCl in Filtrate.—The chloride of sodium is now determined in the filtrate by a standard solution of $AgNO_3$, using a few drops of a saturated solution of potassium chromate as indicator.

Total Mineral Matter (Ash) and Curd.

The methods of estimating curd depend on the principle of first drying a weighed portion of the butter, and afterwards extracting the fat with ether or petroleum. The residual mass is then weighed and the curd determined by loss on ignition. This process is carried on as follows:—

Five to ten grms. of butter are dried at 100° C. for a few hours in a porcelain dish. The dried fat, &c., is filtered through a Gooch crucible, the contents of the dish all brought into the crucible and well washed with ether or light petroleum. The filter crucible is dried for two hours in air-bath and weighed. The curd is then determined by loss of weight on ignition.

The total mineral matter is represented by the residue left after ignition.

Curd and insoluble substances may be estimated somewhat more accurately as follows:—

Place the butter (5—10 grms.) in a Gooch crucible; set the crucible on a pad of blotting-paper in an air-bath (100° C.) for an hour, wash two or three times with ether or light petroleum. Dissolve the salt with hot water, dry at 100° C. and weigh. Any insoluble mineral matter and the ash of the curd is weighed with it in this method.

Casein.

Method of Babcock.—Ten grms. of the dried butter are treated with light petroleum until all fat is removed. The residue is then ignited with soda-lime or treated by the Kjeldahl method.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, February 16th, 1888.

Mr. William Crookes, F.R.S., President, in the Chair.

Messrs. T. A. Lawson and Edward A. Andrews were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Alfred Chiddey, Mount Costigan Smelting Works, Tuena, New South Wales; Harold Nicolai Faber, 56, Dalberg Road, Brixton; James Hart, 131, Embden Street, Manchester; C. Millard King, 63, Frome Park Road, Hornsey, N.; Vivian Byam Lewes, 18, Park Row, Greenwich, S.E.; Frederick Grevile Ruddock, Wilderspool Road, Warrington; H. Belcher Thornton, 11, Esk Terrace, Whitley, Yorkshire; Edward Arthur Wates, 4, Princes Road, Lewisham, S.E.

It was announced that the following changes in the Council List were proposed by the Council:—

As *Vice-Presidents*, Professors Carey Foster and Mallet, *vice* Professors Dewar and Tilden.

As *Members of Council*, Professors Dunstan, Heaton, and Purdie, and Dr. Plimpton, *vice* Messrs. Carteighe, Messel, Newlands, and Stevenson.

Professors Dunstan and Heaton and Dr. Rideal were appointed by the meeting to audit the Treasurer's accounts.

The following were elected Fellows of the Society:—Messrs. Henry Dudley Bevridge, Thomas Fraser Barbour, William H. Barraclough, Alfred Edward Carey, Lewis Smith Cocking, W. Hepworth-Collins, Astley Cooper, John H. J. Dagger, Benjamin H. Gerrans, Christopher James, Charles R. Lafosse, J. Lewkowitsch, Frederick K. S. Lowindes, Thomas Maben, James Mayne, Otto Werbeck, Clifford Richardson, Angus Smith, Sam Smith, Robert Mason Sumner, Arthur J. C. Waterland, John Cuthbert Welch, Emil A. Werner.

The following papers were read:—

11. "*Chemical Investigation of Wackenroder's Solution and Explanation of the Formation of its Constituents.*" By Professor Debus, Ph D., F.R.S.

"Wackenroder's" solution is the solution formed by the action of sulphuretted hydrogen on an aqueous solu-

ion of ulphurous acid till the sulphurous acid is decomposed. The compounds represented by the formulæ $M_2S_3O_6$, $M_2S_4O_6$, $M_2S_5O_6$, and $M_2S_6O_6$, in which M stands for hydrogen or a monovalent metal, are called "Polythionates." The term "acid" is reserved by the author for the so-called anhydrides. The formula SO_2 stands for sulphurous acid, and H_2SO_3 for dihydric sulphite; S_4O_5 for tetrathionic acid, and $H_2S_4O_6$ for hydric or dihydric tetrathionate.

Wackenroder's solution contains, according to our best authors, sulphur in suspension and pentathionic acid in solution. Pure pentathionic acid has never been prepared. The attempts to make salts of the acid also failed. In consequence, Spring a few years ago denied the existence of pentathionic acid, which he declared to be a solution of sulphur in hydric tetrathionate, not in atomic proportions, but of the same description as the solution of sulphur in carbonic sulphide.

To test the correctness of Spring's assertion, the author suggested to Mr. Lewes some experiments with Wackenroder's solution; and Mr. Lewes prepared nearly pure potassic and baric pentathionate. These salts, however, could not be re-crystallised from water, but split up in tetrathionates and sulphur: $K_2S_5O_6 = K_2S_4O_6 + S$. Spring, therefore, would not admit that they were pentathionates, but regards them as mixtures of tetrathionates and sulphur.

In order to remove all doubts about the existence or non-existence of pentathionates, and also to explain some reactions of more than ordinary interest which the author had occasion to observe, whilst Mr. Lewes was carrying out his work, he undertook the experimental investigation described in the paper.

The results briefly stated, are as follows: The filtered Wackenroder solution contains—

(*a.*) Sulphur in suspension in very minute drops.

(*b.*) *A new allotropic modification of sulphur in simple solution, and in the colloidal condition.* This new form of sulphur, Sulphur δ, separates on evaporation of Wackenroder's solution as a yellow, viscous, semi-fluid mass, *partially soluble in much water.* It resembles, in some respects, silica as set free from soluble silicates by strong acids.

(*c.*) Traces of trithionic acid.

(*d.*) Hydric tetrathionate.

(*e.*) Hydric pentathionate.

(*f.*) A polythionate with more sulphur than pentathionates contain, probably hydric hexathionate.

Pure potassic and cupric pentathionates were prepared from Wackenroder's solution, and the reactions of the polythionates carefully investigated. The most interesting of these reactions are *the spontaneous changes of the polythionates in aqueous solutions;* they are indicated by the equations—

(*a.*) $\underset{\text{Pot. pentathionate.}}{K_2S_5O_6} = \underset{\text{Pot. tetrathionate.}}{K_2S_4O_6} + S.$

(*b.*) $\underset{\text{Pot. tetrathionate.}}{2(K_2S_4O_6)} = \underset{\text{Pot. trithionate.}}{K_2S_3O_6} + \underset{\text{Pot. pentathionate.}}{K_2S_5O_6}.$

(*c.*) $\underset{\text{Pot. trithionate.}}{2(K_2S_3O_6)} = \underset{\text{Pot. tetrathionate.}}{K_2S_4O_6} + K_2SO_4 + SO_2.$

d.) $\underset{\text{Pot. trithionate.}}{3(K_2S_3O_6)} = K_2S_5O_6 + 2(K_2SO_4 + SO_2).$

Reactions (*a*) and (*b*) occur reciprocally in either direction with equal facility. From these reactions important conclusions can be drawn with regard to molecular and atomic motion in liquids. The pentathionates resemble persulphide of hydrogen, and are, like ozone and peroxide of hydrogen, endothermic compounds. The similarities which exist, from a chemical point of view, between the polythionates on the one hand and ozone and peroxide of hydrogen on the other, are applied in the paper to explain some of the chief properties of ozone and peroxide of hydrogen.

In the second part of the paper the action of sulphuretted hydrogen and sulphurous acid respectively on the hydrogen salts of the polythionic acids are fully investigated. It is proved that the pentathionic acid of Wackenroder's solution is chiefly derived from the condensation of thiosulphuric acid, thus:—

$$\underset{\text{Thiosulphuric acid.}}{5(S_2O_2)} = \underset{\text{Pentathionic acid.}}{2(S_5O_5).}$$

$$2(S_5O_5) + 2H_2O = \underset{\text{Hydric pentathionate.}}{2H_2S_5O_6.}$$

The final products of the action of sulphuretted hydrogen on hydric tetra- or hydric penta-thionate are water and sulphur. The statement of the text-books that sulphuretted hydrogen and sulphurous acid produce water and sulpnur, is, therefore, correct in so far as the final products are concerned. The polythionates are intermediate products.

Sulphurous acid and potassium thiosulphate or sulphurous acid and the chlorides of sulphur, produce salts of the polythionic acids.

The third part of the paper is devoted to the discussion of the formulæ of the polythionates. It is shown that the following formulæ are the most correct expressions of our experience:—

$K{\cdot}SO_2{\cdot}O$	$KS{\cdot}SO_2{\cdot}O$
$KO{\cdot}SO_2{\cdot}\dot{S}$	$KO{\cdot}SO_2{\cdot}\dot{S}$
Pot. trithionate.	Pot. tetrathionate.
$KS_2{\cdot}SO_2{\cdot}O$	$KS_3{\cdot}SO_2{\cdot}O$
$KO{\cdot}SO_2{\cdot}\dot{S}$	$KO{\cdot}SO_2{\cdot}\dot{S}$
Pot. pentathionate.	Pot. hexathionate.

12. "*Potilizin's Law of Mutual Displacement of Chlorine and Bromine.*" By T. E. Thorpe, F.R.S., and J. W. Rodger.

On heating bromine with an equivalent quantity of an anhydrous metallic chloride in a sealed glass tube free from air at the temperature of the melting point of zinc, Potilizin found that the amount of chlorine displaced by bromine was greater the higher the atomic weight of the metal in the chloride. Experiments were made with the chlorides of sodium, potassium, silver, calcium, strontium, barium, lead, and mercury. Potilizin further found that if A be the atomic weight of the metal, p the percentage of chlorine displaced from its chloride when treated as above, and E its valency, the formula $\frac{A}{pE^2}$ = a constant, held good in the case of lithium, sodium, potassium, silver, calcium, strontium, barium, lead, mercury, bismuth, tin, and iron. He considered the quantity of chlorine displaced to depend on the atomic weight, valency, and temperature. Arranging the metals in accordance with the periodic law in vertical series, the chlorine displaced was as the atomic weight, $\frac{A}{p}$ being a constant for each series.

Berthelot pointed out that displacement of chlorine by bromine was only possible if the heat of formation of BrCl was greater than the heat absorbed in the direct substitution. Such displacements might, he thought, take place at temperatures at which the chloride was dissociated, so that the bromine would be able to unite with the free metal. He repeated Potilizin's experiments, but found no action up to 400°. Potilizin, in answer to Berthelot, repeated his previous experiments, and further varied the mass of the bromine employed. He used sealed vacuous tubes, heating them at 400—515° or at 300—315°, and found that the chlorine displaced varied with the mass of the bromine, but at a given limit increase in the amount of bromine or of the temperature did not affect the quantity of chlorine displaced. He pointed out that the interaction was not in entire accordance with Berthelot's principle of maximum work, but that it depended partly on this principle and also on the atomic weight, mass, valency, and temperature of the interacting bodies. Berthelot attempted to reconcile Potilizin's statements with his principle by assuming that intermediate compounds—metallic perbromides and chlorobromides together with bromine chloride—were formed and dis-

sociated. In the light of such a supposition he considered the displacement of chlorine by bromine if the latter is present in excess, and the small displacements if the two are in equivalent proportions, to be in accordance with the provisions of thermal chemistry.

In answer, Potilizin stated that he verified the formula $\frac{A}{p\Sigma^2}$ = a constant, in the case of 14 chlorides, also in the case of nickel and cobalt. He denied that intermediate compounds could exist at the temperature of the interaction, and thought the cause of the interaction must be sought for "in the intramolecular conditions of the bodies; being probably dependent on the varying rates of the molecules."

No further work appears to have been done on the subject, and in order to test the validity of the law stated by Potilizin the following experiments were instituted:—

An amount of bromine equivalent to about 1 grm. of anhydrous chloride was sealed off in a small glass bulb, and a quantity of the salt, exactly equivalent to the quantity of bromine taken, was weighed out into another bulb, and the two were placed in a piece of glass tubing closed at one end. At about 6 inches from the closed end the tube was thickened in the flame and drawn out into a thick capillary. Beyond this point it was drawn out and bent so as to be evacuated by the Sprengel pump. When the exhaustion was complete the tube was sealed up by directing a blowpipe flame on to its capillary portion; the point was then annealed and the tube allowed to cool. The bromine bulb was next broken and the chloride distributed as uniformly as possible over the inside of the tube, in order to expose it most advantageously to the action of the bromine. By means of an air-bath the tubes were heated to about the boiling point of mercury in some cases and to about 450° in others.

After heating, the tubes were freed from any adherent oxide of iron due to contact with the iron tubes of the bath, by immersion in warm chlorhydric acid, washed, dried, opened by means of a hot wire on a piece of glazed paper, and heated at 120° till the free bromine was expelled and the weight constant. Lastly, the contents of the tubes were washed out and the empty tubes weighed. From the increase in weight of the chloride taken the amount of bromine substituted and hence the chlorine displaced could be calculated. The results of the experiments carried out in this way are given in the subjoined table. Chlorides marked with the same letter were heated simultaneously:—

It will be seen that only on one occasion—in the case of silver chloride—was a number got in anything like agreement with the figures demanded by Potilizin's law. In all other cases the amount of chlorine displaced was considerably less than that required by the law. The table, however, shows, that although the amount of chlorine displaced stands in no definite relation to the atomic weight of the metal in the chloride used, yet in all cases most chlorine is displaced from the chloride of highest molecular weight when several are heated simultaneously. Further, in all cases with the exception of silver chloride, the longer the time of heating the more chlorine was substituted, and hence it might be thought that if the time of heating were sufficiently prolonged a limit would be reached. On the other hand, in no instance was the amount of chlorine displaced in any one chloride proportional to the time of heating; even after heating sodium chloride for 120 hours scarcely half the quantity demanded by Potilizin's law was substituted. In the only case in which Potilizin gives definite data, viz., in the case of barium chloride, the percentage of chlorine displaced was 7·78 on heating from two to six hours at 400°, whereas we obtained only 4·8 on heating for seventeen hours at about 450°.

Chloride used.	Temperature of bath.	Time of heating.	Percentage of chlorine replaced.	Percentage given by the law.
(*a*) NaCl ..	about 350°	8 hours	0·5	5·5
(*b*) NaCl ..	,, 450	14 ,,	1·84	5·5
NaCl ..	,, 450	120 ,,	2·6	5·5
(*a*) KCl ..	about 350°	8 hours	2·7	9·78
(*b*) KCl ..	,, 450	14 ,,	3·4	9·78
(*a*) AgCl ..	about 350°	8 hours	23·3	27·28
(*b*) AgCl ..	,, 450	14 ,,	24·7	27·28
AgCl ..	,, 350	8 ,,	27·42	27·28
(*c*) $SrCl_2$ ..	about 450°	17 hours	1·3	5·2
(*c*) $BaCl_2$..	about 450°	17 hours	4·5	7·78
(*c*) $PbCl_2$..	about 450°	17 hours	5·0	12·4

The authors consider that these observations altogether disprove the validity of Potilizin's law of displacement.

13. "*A Gasometric Method of Determining Nitrous Acid.*" By Percy F. Frankland, Ph.D., B.Sc., F.I.C.

The method is based on the well-known interaction of urea and nitrous acid. The author evaporates a definite volume of the solution containing the nitrite to dryness in a small beaker on the water bath, the residue is then dissolved in a few c.c. of hot distilled water, and transferred along with an excess of urea to a tube standing over mercury. Dilute sulphuric acid is then admitted, whereupon an evolution of nitrogen and carbonic anhydride takes place. The reaction is found to be complete in fifteen minutes. An excess of a strong solution of pure caustic soda having been admitted into the tube to absorb the carbonic anhydride, the residual nitrogen is transferred to a gas-apparatus and measured.

The method was found to yield very satisfactory results.

The method was also employed for determining nitrites in the presence of nitrates and ammonia: the nitrate was destroyed by evaporating one portion of such a mixture with excess of ammonium chloride, and the nitric acid in the residue was then determined by the mercury method; whilst another portion was evaporated with an excess of pure caustic soda—to prevent the destruction of the nitrite by the ammonia present—and in the residue the nitrous acid was determined by the urea method.

14. "*The Action of Some Specific Micro-organisms on Nitric Acid.*" By Percy F. Frankland, Ph.D., B.Sc., F.I.C.

The author has investigated the behaviour, when grown in nutritive solutions containing nitrates, of a number of micro-organisms obtained from air and water, and cultivated in a state of purity. Of 32 different forms so examined, 16 or 17 were found to reduce the nitrate to nitrite more or less completely, whilst the remainder were quite destitute of this power. The behaviour of the various organisms was not altered in this respect by excluding air from the solutions in which they were cultivated. In a number of cases the changes taking place in the condition of the nitrogen were followed quantitatively. In some cases ammonia made its appearance in the solutions, but by quantitative experiments it was found that this ammonia was due to the decomposition of peptone, which was the only other nitrogenous ingredient besides the nitrate in the cultivating medium employed. A number of special experiments were made with two micro-organisms, *Bacillus ramosus* and *B. pestifer*, which powerfully reduce nitrates to nitrites, and which also give rise to the appearance of ammonia in the peptone-culture-fluid. In these experiments it was found that the nitrite produced in a given time was augmented by increasing the organic matter, peptone, and sugar present in the solution, and that the peptone was much more potent in effecting this increase than the sugar. It was further found that the ammonia generated in these experiments was increased by raising the proportion of peptone to sugar, and diminished by increasing the proportion of sugar to peptone.

In nearly all cases in which partial or total reduction of

nitrate to nitrite had taken place, the sum of the nitrogen as nitrate and nitrite in the fermented solution was practically identical with the nitrate in the original unfermented solution; whilst in those cases in which no reduction to nitrite took place, the nitrate in the solution remained practically unaffected by the growth of the micro-organisms. In one case, however, it was found that an organism, *B. aquatilis*, which does not reduce nitrates to nitrites, caused by its growth, the disappearance of a considerable proportion of nitric nitrogen, the deficiency not being accounted for by the small proportion of ammonia which was generated in the solution. It is pointed out how this difference in reducing power may in certain cases be of great value in distinguishing between micro-organisms morphologically very similar.

15. "*The Action of Phosphorus Pentachloride on Salicylaldehyd.*" By Charles M. Stuart, M.A.

The author finds that phosphorus pentachloride converts salicylaldehyd into the phosphate of dichlororthocresol, $PO(O{\cdot}C_6H_4.CHCl_2)_3$, and not into dichlorothocresol, as stated by Henry (*Ber.*, 1869, 135).

Dichlororthocresylic phosphate is not altered by boiling with potassium hydroxide solution. By the action of phosphorus pentachloride on orthomethoxybenzaldehyd, orthomethoxybenzal chloride, $C_6H_4(OCH_3){\cdot}CH_2Cl_2$, is obtained; this is readily re-converted by the action of warm water into the aldehyd from which it was formed.

16. "*Some Interactions of Nitrogen Chlorophosphuret.*" By Ward Couldridge, B.A.

The paper is chiefly devoted to the description of experiments on the action of amines on nitrogen chlorophosphuret, $P_3N_3Cl_6$, the compound which results on heating together phosphorus pentachloride and ammonium chloride; the small yield obtained by this process is attributed by the author to the formation of phospham, $P_3N_3(NH)_3$, by the action of ammonia on the chlorophosphuret. He finds that the compound $P_3N_3(NH{\cdot}C_6H_5)_3$, which Hofmann prepared by treating the chlorophosphuret with aniline, is not altered by heating with muriatic acid at 150°, but that at 250° it is resolved into phosphoric acid, ammonium chloride and aniline chlorhydride. By the action of orthotoluidine, a compound of the formula—

$$P_3N_3(NH{\cdot}C_6H_4{\cdot}CH_3)_6$$

was obtained, and similar compounds were prepared from phenylhydrazine and piperidine. Attempts to displace the chlorine by cyanogen were unsuccessful, and experiments with sodium and with zinc ethide also gave negative results.

17. "*Action of Alcohols on Ethereal Salts in Presence of Small Quantities of Sodic Alkylate.*" By T. Purdie, Ph.D., B.Sc., Professor of Chemistry in the University of St. Andrews, and W. Marshall, B.Sc.

The addition of a minute quantity of sodic alkylate to a mixture of an alcohol and an ethereal salt induces an extensive interchange of alkyl radicle between the two substances. The authors having examined the interaction in the case of a number of ethereal acetates and alcohols of the $C_nH_{2n+1}OH$ series, find that a much greater interchange occurs when the alcohol of complex radicle acts on the ethereal salt of simple radicle than in the converse interaction. The numerical results obtained indicate that, excluding the methyl radicle, the affinity of the alkyl radicles for the hydroxyl-oxygen of the acid, as measured by the interaction under consideration, increases with increasing complexity of the alkyl radicle; but that with regard to the methyl-radicle its affinity is greater than that of the ethyl and less than that of the amyl radicle.

18. "*Note on the Densities of Cerium Sulphate Solutions.*" By B. Brauner, Ph.D.

The author has determined the densities of solutions of the anhydrous and of the hydrated salt, and finds that the values are identical for solutions of equal concentration.

PHYSICAL SOCIETY.

February 25th, 1888.

Professor Reinold, F.R.S., President, in the Chair.

Mr. Hugh Frank Newall was elected a Member of the Society.

The President read a letter received from the Council of the Royal Meteorological Society, referring to the forthcoming Exhibition of Apparatus used in Observations of Atmospheric Electricity, and requesting the loan of such apparatus belonging to Members of the Society.

The following papers were read:—

"*Note on the Efficiency of Incandescent Lamps with Direct and Alternating Currents.*" By Prof. W. E. Ayrton, F.R.S., and Prof. J. Perry, F.R.S.

This relates to the question whether the "efficiency" (candles per Watt) is greater or less for alternating than for direct currents. Experiments made by Messrs. Shepherd and Wheatley, two of the students at the Central Institution (to whom the authors express their thanks for the valuable assistance rendered), show that no appreciable difference can be detected when the lamp is at the same candle-power.

In performing the experiments three way switches, in connection with Gramme and Ferranti machines, were arranged so that the current through the lamp could be quickly changed from direct to alternating, or *vice versâ*, adjustable resistances having been previously placed in the two circuits to give equal readings on a Cardew voltmeter placed as a shunt to the lamp. The currents were measured by a reflecting dynamometer, wound with fine wire, in order to make the error due to unequal current density over the section, negligible. The problem has also been investigated from theoretical considerations, but the results, as yet deduced, would not lead the authors to anticipate the equal efficiency found experimentally.

An interesting discussion followed, in which Mr. Swinburne, Prof. S. P. Thompson, Mr. Boys, and the Authors took part.

"*Observations of the Height, Length, and Velocity of Ocean Waves.*" By the Hon. Ralph Abercromby, F.R. Met. Soc.

Several sets of observations were made by the author in the South Pacific in 1885. The heights were measured by a sensitive aneroid, and the length and velocity by a chronograph assuming the length and speed of the vessel to be known. The largest waves observed in a heavy sea gave a height of 46 feet, length 765 feet, velocity 47 miles per hour, and time-period of 16·5 sec. Great discrepancies exist between the results of different observers, which the author believes to be chiefly due to the comparative rarity of well-defined simple waves.

Replying to a question from Mr. Baily, the Author said the effect on the barometer, of the difference of wind pressure on the two sides of a wave, was negligible.

"*On the Temperature at which Nickel begins suddenly to lose its Magnetic Properties.*" By Mr. Herbert Tomlinson, B.A.

Different authorities give different values ranging from about 300° to 400° C. In investigating the subject the author found that the said temperature depends on the magnetising force used; *e.g.*, with magnetising forces of 5, 99, and 182 units, the temperatures at which the permeability attained its maxima were 287° C., 248° C., and 242° C; and those corresponding to permeability o were 333°, 392°, and 412° respectively.

From these above results it will be seen that for small magnetising forces the change of permeability from maximum to o is much more sudden than for the greater forces. As in iron, the permeability decreases as the magnetising force increases. An experiment was shown in which a nickel-plated brass wire was heated to dull redness whilst suspended between the poles of an electro-

magnet, and allowed to cool. When the critical temperature was attained the wire was suddenly attracted to one or other of the poles.

In reply to Mr. Shelford Bidwell the Author stated that the changes in permeability due to ordinary atmospheric changes of temperature were considerable, when small magnetising forces were used.

"*Experiments on Electrolysis.*" By Mr. W. W. Haldane Gee, B.Sc., Mr. H. Holden, B.Sc., and Mr. C. H. Lees, B.Sc.

Whilst studying some electrolytic polarisation phenomena with palladium electrodes in dilute sulphuric acid (pure), a dense liquid was seen, *after reversing the current*, to flow downwards in streaks from the anode.

The paper is devoted to the investigation of the character of the liquid streaks, and the authors conclude that the streaks are of concentrated sulphuric acid formed by the union of the hydrogen (occluded by the electrode whilst serving as cathode) with the SO_4 liberated at the same electrode when the current is reversed.

Similar streaks were found with phosphoric acid, &c.

In their next paper the authors hope to describe some experiments in which these and similar effects become of great importance in changing the resistances of electrolytes.

CORRESPONDENCE.

INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—Mr. R. J. Friswell, in his letter of February 18th (Chemical News, vol. lvii., p. 79), says he was one of the original Council and had some share in the movement which brought about the foundation of the Institute, and I therefore should like to ask him :—

What actual substantial benefits the Institute was intended to confer upon its Fellows over and above those enjoyed by non-Fellows ?

What benefits—substantial, not sentimental—has the Institute conferred upon its provincial Fellows in return for their support ?

What substantial benefits have provincial Fellows a right to expect from the Institute ?

A satisfactory answer to these questions will do much to remove the existing discontent. Of course this cannot appear before the new Council is elected, but a few straws of this kind may show which way the wind blows, and guide their future course.—I am, &c.,

W. Jesse Lovett.

MODIFICATION OF SOXHLET'S APPARATUS.

To the Editor of the Chemical News.

Sir,—I have read with interest Mr. J. J. Barlow's article (Chemical News, vol. lvii., p. 56) on "An Improved Modification of Soxhlet's Apparatus for the Extraction of Oil and Fat in Plants, Foods, &c." ; but although Mr. Barlow's device may be an improvement as far as economy goes, I venture to assert that it can scarcely be looked upon as an improvement in point of efficacy. On the other hand, it must, in my opinion, be looked upon rather as an improvement in the wrong direction, since it lacks the most important function of Soxhlet's cleverly constructed arrangement, of bringing the substance to be extracted into contact with the *freshly distilled* solvent until the latter syphons itself off. This contact lasts the whole time during which the extraction is going on, whereas in Mr. Barlow's arrangement the freshly distilled liquid only comes into contact with this substance periodically for a few seconds, viz., while the liquid which has collected in T is being syphoned off, and then the greater part will trickle down the side of the bag and have little or no effect.

Another objection to Mr. Barlow's "Improved Modification" lies in the fact that the cotton bag (which, by the way, would certainly not be fine enough for some substances) lies soaking in the concentrated extract contained in the flask. When taken out it must necessarily retain by capillary attraction a very considerable proportion of the latter, which if not taken into consideration would lead to serious errors.

Upon the whole, I fail to see any improvement in Mr. Barlow's arrangement on the rough and ready method of boiling the substance with the solvent in a flask, and then filtering.—I am, &c.,

Edmund Knecht, Ph.D.

Chemistry and Drying Department,
Bradford Technical College, Feb. 20, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 6, February 6, 1888.

One of the Bases Extracted by M. Morin from Liquids which have undergone the Alcoholic Fermentation.—M. Tanret.—One of these bases has received the formula $C_7H_{10}N_2$. The author, in June, 1885, made it known that by the action of free ammonia or of the ammoniacal salts of organic acids upon glucose there are formed volatile bases which he named glucosines. M. Morin's base corresponds in its formula and properties to glucosine β.

Zeitschrift fur Analytische Chemie. Vol. xxvi., Part 3.

Determination of Sulphur and the Halogens in Organic Substances.—P. Claesson.—This paper requires the accompanying illustration.

Determination of Crystalline Water in Organic Matter Containing Iodine.—E. Ostermayer.—An ordinary combustion-tube 30 c.m. in length is connected on the one end with an aspirator and an intermediate calcium chloride tube, and at the other end with an upright tube containing the substance under examination, which is again connected with a "desiccation system." The combustion tube is charged with two spirals of copper, or preferably of silver, which can be heated by means of two Bunsen burners. The tube containing the substance is immersed for two-thirds of its depth in an oil-bath which is heated to the temperature necessary for the determination. The spirals are slightly heated, and a current of dry air is aspirated through the tube. Any iodine which is carried along by the air is retained by the spirals, whilst the watery vapour alone arrives in the calcium chloride tube.

Determination of Fusel Oil.—H. Rose compares the increase of volume observed in known quantities of chloroform shaken up respectively with a fuseliferous spirit and with a pure spirit of the same strength, and calculates the difference as fusel. J. Traube determines the heights to which pure and fuseliferous spirits ascend respectively in capillary tubes under identical conditions.

Examination of Mealy Substances for Binitrocresol and Picric Acid.—Fleck.—Both these colouring-matters may be extracted with alcohol. The solution is evaporated down in a small porcelain capsule ; upon the residue is poured a little dilute hydrochloric acid (10 per cent). Picric acid is at once decolourised ; bininitrocresol not until a few minutes have elapsed. If a piece

of pure zinc is then laid in the liquid and let stand without heating a fine blue colour appears in one to two hours in case of picric acid, and a light blood-red in case of binitro-cresol.

Examination of Butter.—Notices of a number of papers on this subject by E. Sell, A. Mayer, A. Müller, J. Skalweit, Wolckenhaar, E. König, C. Virchow, E. Duclaux, A. Upmeyer, Scheffer, W. Fox, and J. A. Wanklyn.

The Flashing-point of Crude Petroleum.—Th. Rosenbladt (*Chemiker Zeitung*).—The process in question is not given.

Proportion of Phenol in Crude Carbolic Acid.—H. Beckurts.—The author mixes a given volume of the sample with an equal volume of petroleum-ether and shakes up the whole in a graduated jar with a 10 per cent soda-lye. A complete separation of the alkaline liquid from the hydrocarbons ensues with ten minutes. The volume of the matter insoluble in soda, less the volume of the petroleum-ether added, shows the volume of the neutral oils present.

Examination of Paper.—C. Wurster.—The author accounts for the yellowing of paper on exposure to light by the formation of a colouring-matter connected with an "activation" of oxygen. This process he refers to the presence in the paper of the resin used in sizing, which, in a state of fine division, seems to act like oil of turpentine. He shows the presence of activated oxygen by means of tetra-methyl-para-phenylen-diamine paper (Schuchardt, of Goerlitz). If such paper is moistened with water and pressed between paper sized with resin it turns in a few minutes to a blue-violet, whilst paper free from resin is scarcely coloured. To detect mechanical wood-stuff in paper Wurster presses slightly a test-paper saturated with dimethyl-para-phenylen-diamine and folded twice or four times between sheets of the sample. If mechanical wood-stuff is present the paper turns red. Chemical wood-stuff shows this reaction very slightly or not at all. Many papers turn metal foil, especially silver, brownish or yellowish, and have an unpleasant action upon metal objects with which they come in contact. This depends on the presence of sulphur or chlorine. According to R. Kayser these impurities may be detected by placing a piece of silver-leaf between sheets of the paper and exposing it to a jet of steam for half-an-hour.

MEETINGS FOR THE WEEK.

MONDAY, 5th.—Medical, 8.30.
— Society of Chemical Industry, 8. "The Recovery of Sulphur from Alkali Waste by Means of Lime Kiln Gases," by Alexander M. Chance.
— Royal Institution, 5. General Monthly Meeting.
— Society of Arts, 8. "The Modern Microscope," by John Mayall, Jun.

TUESDAY, 6th.—Institution of Civil Engineers, 8.
— Pathological, 8.30.
— Royal Institution, 3. "Before and After Darwin," by George John Romanes, F.R.S.
— Society of Arts, 8. "South African Goldfields," by W. H. Penning, F.G.S.

WEDNESDAY, 7th.—Society of Arts, 8. "Framework Knitting," by W. T. Rowlett.

THURSDAY, 8th.—Royal, 4.30.
— Royal Society Club, 6.30.
— Telegraphic Engineers, 8.
— Medical, 8½30. (Anniversary).
— Mathematical, 8.
— Royal Institution 3. "Microscopical Work with Recent Lenses on the Least and Simplest Forms of Life," by The Rev. W. H. Dallinger, LL.D., F.R.S.

FRIDAY, 9th.—Astronomical, 8.
— Quekett Club, 8.
— Royal Institution, 9. "S. T. Coleridge," by Leslie Stephen, M.A.

SATURDAY, 10th.—Royal Institution, 3. "The Modern Drama: French," William Archer.
— Physical Society, 3. "On a Reflecting Galvanometer," by G. L. Addenbroke. "On a Theory concerning the Sudden Loss of Magnetic Properties of Iron and Nickel at a High Temperature," by Mr. Herbert Tomlinson.

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ON THE

DETERMINATION OF THE AMOUNT OF MORPHIA PRESENT IN OPIUM.

By E. F. TESCHEMACHER and J. DENHAM SMITH.

The above was the title of a Memoir published by the late E. F. Teschemacher, jun., in the Chemical News of February 2nd, 1877, re-printed and distributed by him amongst analysts and others known to be interested in the subject. This title we also adopt as best describing the results of the last ten years' work on numerous samples of opium we have examined during this time, our amendments in the process of 1877, and our careful investigation of some of the best, most prominent, and authoritative processes published by others during, or somewhat before, this period.

In 1882 Mr. Allen, of Sheffield, was good enough to send us an excerpt of some 150 pages from his important work, "Commercial Organic Analysis," containing many useful details and remarks on the determination of morphia in opium. He begins by saying—"The accurate estimation of morphia in opium is attended with peculiar difficulties, and hence few of the numerous published processes for the assay of opium are really trustworthy." Permit us to substitute "none" for "few," and, qualifying this by "within our knowledge," we most heartily agree with Mr. Allen; but must be allowed to totally differ from him when he adds—"In addition to the method of assay prescribed in the *British Pharmacopœia*, the following are very satisfactory processes."

To this process of the *British Pharmacopœia* (1867) we shall presently return, whilst as to that due to Prollius, and its modification by Petit, cited by Mr. Allen, they cannot possibly yield results in the least degree trustworthy, owing to the large quantities of alcohol employed in both processes.

We now come to the method of Flückiger, extracted from the *German Pharmacopœia Report*, by which, after the treatment of the dried opium by ether, to remove wax, narcotin, and colouring-matter, the residual opium is exhausted by water, and a known portion of this solution by a mixture of ether and alcohol of 0·815 sp. gr.; afterwards by solution of ammonia, and collecting the morphia after the expiration of twenty-four hours. Here, again, the quantity of alcohol must interfere with the correctness of the results, and this conclusion appears to have been experimentally arrived at by Mylius, who found the determination of morphia by this process to be below the truth. Mylius, however, is guilty of proposing to add a given weight to that of the morphia obtained, to ensure, in his opinion, a correct result,—to our eyes an unpardonable sin in an analyst, as tampering with the actual results, and thus leading directly to untrue and fallacious returns.

This process of Flückiger seems to attract analysts, for we find in page 724 *et seq.* of the *Pharm. Journ.* (vol. xii.) full details of a method devised by Dr. E. R. Squibb, of the U.S.A., and based on Flückiger's method; but alas! the new method is so overlaid with detail that we fear the tyro in analysis—for whose use these instructions must have been intended—would be crippled by their minuteness and multiplicity, so that his best efforts would most likely be attended by disappointment and failure. Even the editor of the *Pharm. Journ.*, who has reprinted Dr. Squibb's emendation of Flückiger, thinks it requisite to warn his readers who may adopt this method that they must "not be discouraged if very many trials be needed to render them expert enough to obtain tolerably accurate and uniform results,"—an opinion so discouraging that we fear few would venture on mastering this process, especially as the author of it appears to have concluded his remarks with, to our minds, this fatal one,—"but there will always be some loss."

By the courtesy of Mr. C. M. Stillwell, M.A., of New York, we have received a memoir entitled "On the Analysis of Opium," which proves to be not a method for the analysis of opium, but a still further modification of the Flückiger-Squibb process for the determination of morphia present in opium.

A reprint of Mr. Stillwell's paper occurs in the Chemical News (vol. lv., pp. 41 and 54) As Mr. Stillwell sets a very high value on his process, it is but right that we should let him speak for himself when introducing it. He says:—"In presenting a method for the analysis of opium, as an addition to the many processes published from time to time, I feel justified on account of the importance which a correct analysis of this costly substance demands. The use of the two washing solutions, to be described hereafter, is an important step towards obtaining a pure precipitate of morphia; and the final purification of the crystalline precipitate, proposed by myself, I find to be absolutely necessary for the correctness of the analysis. To this latter point I call special attention. The process of Dr. Squibb, used as he directs, *will give results which are almost exactly comparable amongst themselves.*" This *dictum* of Dr. Squibb we have ventured to italicise, which we have found to be so constant and true that for convenience sake we have dubbed it "Squibb's Law." "It can be used, therefore, as a control; but to obtain analytical results such as are needed for buying and selling, a still greater degree of accuracy is required. For this purpose I believe the method now to be described to be of great value."

Instead of so doing Mr. Stillwell delays the fulfilment of this promise for a space of upwards of three pages of his pamphlet, when he renews his promise, and, we are glad to say, keeps it:—

"As regards the accuracy of the process, about to be described, the following results may be of interest:—An opium, very uneven in quality, was sampled by one of our men, and I made the analysis, obtaining water 24·30, morphia 11·75 per cent. Three months afterwards the same lot was re-sampled, and analysed by me in duplicate: the results were—Water 24·70, morphia 11·70 and 11·82; average 11·76 per cent."

This test scores for the storage and sampling, but as for its testimony to the accuracy of the process we fail to discern it, whilst we find a confirmation of Squibb's Law, which we find to be very constant with opium processes carried out in precisely similar methods, and yielding similar, it is true, but far distant from accurate, results.

To quote Mr. Stillwell *in extenso* would but needlessly weary both our readers and ourselves, so that we shall confine our description to a summary of his process, in the which we are the more encouraged by his own example of summarising his method at the conclusion of his memoir. After directions for the sampling of and the preparation of the sample, the process begins by exhausting about 10 grms. by water; then concentrating this aqueous solution in a water-bath to 25 c.c., to which 5 c.c. of alcohol, of 0·820 sp. gr., are to be added and stirred to ensure mixture. This solution is now to be transferred to an Erlenmeyer flask, and 5 c.c. more of alcohol are to be added, and the liquids mixed by a rotary motion. Now add 30 c.c. of ether, of 0·728 sp. gr., and mix again by rotation; to this further add 4 c.c. of solution of ammonia, sp. gr. 0·960, and shake the flask vigorously until an arenaceous precipitate falls. Set the flask aside for twelve hours. Then filter the ethereal portion from the flask as closely as possible, having previously well wetted the filter with ether; add 20 c.c. of ether to the solution in the flask, and rotate; again pour the ethereal solution on to the covered filter, and finally wash the filter with 5 c.c. of

ether, and allow it to drain and dry. Then collect on the filter the crystalline contents of the flask; rinse this twice, with 5 c.c. of water each time. Wash the filter and crystals carefully with 10 c.c. of water; drain and dry this first on bibulous paper, and then at 212° F. This, with any crystals adherent to flask, will give the total yield of morphia in clean, distinct, small light brown crystals. This is apparently the conclusion of Mr. Stillwell's process, described in seven pages of letterpress.

"This process, according to the skill and care bestowed, will give uniform results within two- or three-tenths of a per cent." We are now told that with adulterated opiums "the results are almost always too high," whilst with poor opiums these "are liable to be too low," involving a serious modification of the process. These conditions we must submit are almost, if not wholly, condemnatory of the process; whilst now we quickly light on the statement that, "in following out the above plan of Dr. Squibb, several difficulties are met with."

The above plan of Dr. Squibb. What does this mean? We hark back until we find the name of Dr. Squibb, when it is quoted in connexion with and in condemnation of "processes which depend on the use of lime, and of an aliquot portion of the filtrate"; and this is considered and concluded in p. 4 of the pamphlet. Mr. Stillwell afterwards continues the description of his own process, sometimes with, but more often without, quotation-marks, and sometimes commencing a sentence with quotation-marks which are omitted when the paragraph is concluded, to the utter bewilderment of his readers. At last we are driven to the belief that when inverted commas are used, or partially used, they signify Flückiger's process amended by Dr. Squibb; when they are not used, Dr. Squibb's process amended by Mr. Stillwell. It is, however, most difficult to decide whether it is Dr. Squibb speaking or Mr. Stillwell. It is Mr. Stillwell, most certainly, who says in p. 10 "In following out the above plan of Dr. Squibb several difficulties are met with." These difficulties appear to be a deficiency of ether, and also of water used for washing the precipitate of morphia, &c., obtained in Dr. Squibb's process, which contains "insoluble matter, resinous and other organic matters, and meconate of lime, the latter constituting about 25 per cent of the impurities present. The average amount of the impurities present in the crystals obtained by his process is 8 per cent of the weight of the crystals. The meconate of lime extracted by the acid solution of the opium is retained in solution until the addition of ammonia, when it is precipitated with the crystals of morphia, and remains with them until the final weighing. The resinous and other organic matters soluble in alcohol, but insoluble in water, are not thoroughly removed by the limited washing given in his process, and no provision is made for their subsequent removal."

Alas for Dr. Squibb and his amended Flückiger process! Will our readers please to remember that it is Mr. Stillwell speaking, not Teschemacher and Smith?

These considerations, which generally we must endorse, have compelled Mr. Stillwell to a fresh start by adopting the *morphiated spirit* and *morphiated water* described by our late Mr. Teschemacher, jun., and long employed by us. Of these reagents Mr. Stillwell observes:—"By washing with these solutions the extractive matter is completely removed from the filter-paper and crystals of morphia." And continues, "The thorough washing with 'morphiated spirit' which I employ takes out these substances, and the subsequent treatment with 'morphiated water' removes those insoluble in alcohol, so that the chief impurity present in the crystals of morphia obtained by my modification of the process is meconate of lime, together with some organic matters insoluble in water and alcohol."

Our author now proceeds to what in his summary he terms "the purification of the morphia," by treating the impure precipitate with hot alcohol, and washing with the same. "Dry and weigh the insoluble, which is to be subtracted from the first weight of the precipitate, to get the amount of morphia present"; that is, he regards the whole of this precipitate soluble in alcohol as being pure morphia! unmindful of the fact that all the numerous opium derivatives are equally soluble in hot alcohol. Had he adopted the use of benzene from the late Mr. Teschemacher he would have escaped this danger, as morphia alone of the opium derivatives is insoluble in benzene, excepting narceia, which, however, seems to be soluble in some one of our reagents,—possibly the morphiated water. We may here interpolate a test experiment on this point:—

200 grains of opium (with 50 grains alcohol)	= 9·65	p.c. morphia.
The same repeated	= 9·65	,, ,,
The same, with 4·50 grains of narcein dissolved in muriatic acid added	= 9·77	,, ,,

This 0·12 per cent excess may be disregarded.

Mr. Stillwell does not instance any results of his process, whether with or without the use of our morphiated water or spirit. Let us supply this omission, with the amount of morphia we obtained, chiefly during last summer, when examining Mr. Stillwell's process to determine its trustworthiness.

From 5 Samples of Opium—	F.	G.	H.	I.	K.
Stillwell's process exactly followed yielded p.c. of morphia..	8·51	8·40	9·940	8·40	9·55
Teschemacher - Smith process yielded p.c. of morphia..	9·64	9·40	10·60	9·40	11·20

So that in practised hands Mr. Stillwell's process, with five different samples, invariably yielded results lower than our method, being a sum of 44·80 of morphia against 50·24 with ours, and involving a loss of more than 10 lbs. on every 100 lbs. of morphia,—no trifle this.

Observation has forced upon us the conviction that the use of alcohol in morphia processes, beyond a most limited quantity, is incompatible with any reliance on the results obtained. We find that morphia is soluble to the extent of 1·88 parts to 1000 of ether-alcohol, and we think it would dissolve far more in crude opium solutions, where glucosides are present: this invalidates Flückiger's process. It is also an obstacle to the crystallisation and deposit of all the morphia when alcohol is present to any extent. Yet if none is used, and the morphia precipitated without the presence of alcohol, it becomes most difficult to cleanse in the subsequent filtration and washing.

We hope to be pardoned for subjoining a Table showing the influence of varying quantities of alcohol on the amount of morphia obtained of much significance to the analyst.

TABLE.

Seven equal weighed quantities (each = 200 grains opium) of an extract of opium, 600 measured grains of ether, and 50 grains of solution of ammonia (containing half water and half liquor ammoniæ, sp. gr. 0·880), added to each, and the following amounts of alcohol, gave—

Alcohol added, sp. gr. 0·820.	Weight of Alkaloidal Precipitate.	Weight after treating with Benzene.	Titrated and calculated to pure Cryst. Morphia.
None	34·80	26 60	25·55
50 grains	34·20	26·40	25·55
100 ,,	32·50	25·80	25·10
150 ,,	31·00	24·60	23·65
200 ,,	29·00	23·80	23·15
250 ,,	27·70	22·80	22·20
300 ,,	26·50	22·10	21·25

Thus we think 50 grains is the limit of alcohol to be used.

We now proceed to another and wholly different plan, which, if we understand Mr. Allen aright, was selected,

after much examination and research, by Prof. Prescott, and recommended by him to the Committee of Revision of the United States *Pharmacopœia*. This seemingly is known as the Hager-Jacobsen process. This we followed with the greatest care, using an opium we have largely used in this enquiry, yielding us 11·20 per cent of morphia and 14·50 per cent moisture, but which with the Hager-Jacobsen method—which we are given to understand is much used in the United States—gave us but 9·05 per cent of morphia. One trial, but involving this tremendous loss of 2·15 per cent, was conclusive with us, seeing that about 100 grains of dry opium were extracted with some 1150 grains of water, and the morphia obtained directly by lime and muriate of ammonia from this dilute solution. Now considering that 200 grains of the opium we used in the narceia experiment, extracted by water and reduced to 300 fluid grains, yielded by our method 9·65 per cent of morphia, and repeated also 9·65 per cent, whilst with 700 grains of water it yielded but 8·20 per cent, and with 1100 of water only 7·84 per cent of morphia, it became clear enough what had become of the morphia, and that the solubility of morphia in water—wholly ignored by these gentlemen in the United States—proved absolutely fatal to this process admired and seemingly adopted by Prof. Prescott and others.

We have considered Godeffroy's process. As in the foregoing one of Prescott's, this is quite idle from the amount of water, not to dwell on other faults. Then that of the Austrian *Pharmacopœia*. With this the loss of morphia must be tremendous; with four results the yield of impure morphia is cited as being 4·17, 2·04, 0·253, and 0·30 per cent. E. Merck's process, from the quantities of water and spirit used, let alone other sourcess of loss, must be rejected; whilst a method by v. Peyrer is ineffective, the products being crude morphia, which is regarded as being equal to pure morphia in compensation for the loss of this alkaloid, which we cannot admit. So that out of twenty determinations of morphia by these four methods, with six opiums examined, but two have any pretension to agree, and these two differ 1 per cent. We meet with Flückiger again, who need not detain us further than to quote that "he and others repeatedly obtained 0·433 grm. of morphia from 4 grms. of opium, which from Messrs. Squibb and Stillwell cannot be correct results, and only furnishes us with a further instance of Squibb's Law, that these processes "will give results almost exactly comparable among themselves." Venturini has examined several methods of determining the amount of morphia present in opium. He finds "that most of the methods are unsatisfactory, as giving either too low results or yielding impure morphia," in which opinion we agree.

(To be continued.)

THE ACTION OF SULPHUR VAPOUR ON METALLIC COPPER.

By H. N. WARREN, Research Analyst.

The general action of sulphur on metallic copper is altogether too well known to require explanation, everyone possessing a scientific knowledge, however slight, being perfectly aware of the reaction which attends a mixture of copper turnings and sulphur; on applying heat, the whole mass becoming converted into copper sulphide. Quite a different phenomenon is observed when the vapour of sulphur is used. Take, for example, a crucible containing about two ounces of molten copper upon the surface of which a piece of brimstone has been thrown; the crucible at the termination of the reaction being allowed to cool is next broken, and the button of apparently cupric sulphide extracted; a slight blow with the hammer, however, at once unveils a button of pure copper surrounded by a wall of cupric sulphide, and penetrated to an extent in accordance with the amount of sulphur employed, the penetration being perfectly equal, the extracted button, at the same time, possessing a complete absence of sulphur when examined. In a second experiment a rod of copper one inch in width was taken, and exposed to a dull red heat only, for the space of half an hour, and to the action of sulphur vapour, being afterwards cooled and examined by breaking the point; it was found to have been almost entirely and equally penetrated, so as to readily admit of the wire remaining to be easily dislodged without breaking the casing of cupric sulphide. The above-mentioned results, however, were only obtained when good commercial copper was used, arsenical copper, or the like, being penetrated unevenly, or generally forming a sulphur regulus with the whole of the remaining copper employed, while copper containing zinc, or bars of brass, were absolutely unaffected unless first rendered liquid according to the former experiment.

Everton Research Laboratory,
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THE CHEMISTRY OF THE ONION AS A FIELD CROP IN AUSTRALIA.

By R. W. EMERSON MACIVOR, F.I.C., F.C.S., F.R.G.S., &c.

It is remarkable that little or nothing should have been published about the chemistry of the onion as a field crop, and that a complete analysis of the popular vegetable is not to be met with in any standard work of reference. The following short note on the subject, even if incomplete in many respects, may prove interesting, containing as it does the results of an inquiry instituted some years ago in a country where the crop in question thrives to perfection.

The Barwon district in the colony of Victoria is the only part of Australasia where the onion is extensively cultivated as the principal field crop. The soil, climate, and situation are specially favourably to the healthful growth of the plant.

The soil is, for the most part, a chocolate loam of basaltic origin, possessing the depth, porosity, and chemical composition peculiar to its class. In a virgin state it contains sometimes as much as 0·28 per cent of nitrogen and 0·20 per cent of phosphoric acid extractable by hydrochloric acid.

In some places where the soil was naturally poorish the yield of onions does not now reach the average of former years, owing, as experience with different manures would indicate, to the removal in crops and otherwise of the original stores of available nitrogen. Though non-nitrogenous guanos and superphosphates have in a few instances slightly increased the crop, it is found that manures containing nitrogen in the form of sulphate of ammonia or as a constituent of blood guano produce more satisfactory results. The liberal use of superphosphate mixed with sulphate of ammonia has invariably proved more beneficial on the poorer land than superphosphate alone. The largest returns, however, have resulted from the joint use of a fertiliser composed of the sulphates of ammonia and potash and superphosphate. I have known an application of about 4 cwts. per acre of this mixture to more than double the crop when the same quantity of the same superphosphate only slightly increased the yield from an identical soil.

The farmers are of opinion that onions produced by the aid of purely chemical manures keep in good condition for a longer period than those obtained from ground which is naturally "forcing," or which has been recently manured with rich farmyard manure.

It is the practice with some of the farmers to prepare the comparatively "worn-out" soil by manuring with phosphatic guano and sowing a pea crop before again putting in onions. In this way a better yield is obtained

than after another crop of onions. Whether or not this result is in part due to the legume inducing the action of nitrifying ferments by which the inert nitrogen of the soil is rendered available, it is of course impossible to say, but that the onion, in common with other crops, depends upon the soil for its supplies of nitrogen, is in my opinion pretty clear.

The mean composition of air-dried onions grown on unmanured land I found to be as follows:—

Water	894·8
Combustible matter (N = 2·37) ..	101·0
Ash	4·2
	1000·0

The total nitrogen and mean composition of the ash show that an average crop of, say, eight tons will remove from an acre—

N	42·48	lbs.
K_2O	29·36	,,
Na_2O	1·88	,,
CaO	6·52	,,
MgO.	2·70	,,
Fe_2O_3	0·30	,,
P_2O_5.	10·88	,,
Cl	0·80	,,
SO_3	22·90	,,
SiO_2.	1·72	,,
	119·54	,,

The total sulphur in the air-dried onions I found to average 0·051 per cent.

ON THE RANGE OF MOLECULAR FORCES.*

By A. W. RÜCKER, M.A., F.R.S.

The subject on which I have been asked to address the Chemical Society is the Range of Molecular Forces, and it will perhaps be well that I should, by way of prelude, explain the meaning which I myself attach to that term.

The investigation of the movements of a group of atoms or molecules is—though far more complex—in some respects similar to the study of the solar system. Newton proved that the sun, the planets, and their satellites behave as if a mutual action at a distance taking place between them modified their motions in accordance with a very simple rule. The wonderful impetus which this rule—the law of gravitation—gave to astronomy has led to many attempts to apply a similar method to molecular dynamics. Newton's law is thus frequently regarded as being only the first term of a more complex expression which, if complete, would—on the hypothesis of action at a distance—give the true law of mutual force between the ultimate particles of matter. The first term expresses all the results of experiment when the distances between the particles are considerable, but is insufficient when they are near together. The investigation of the other terms, which then become important, may be properly spoken of as the study of molecular forces.

Sir William Thomson (*Proc. Roy. Institution*, vol. xi., Part III., p. 483) has indeed expressed the opinion that it is possible that the phenomena of cohesion and others which are ordinarily ascribed to a departure at small distances from the law of gravitation, may not be inconsistent with it. In that case the additional terms are introduced by the attempt to apply a formula founded on the assumed continuity of matter to phenomena which are caused by its "coarse grainedness." Interesting as this suggestion is, it has not been worked out sufficiently to make it easy to translate all that we know of molecular action into language consistent with it. I shall, therefore, adhere to the ordinary usage, and assume that it is probable that a somewhat complex expression is required for the full statement of the law of force between two molecules.

If this formula were fully known, the physical interpretation to be given to it would still be open to discussion. Formerly it would no doubt have been considered sufficient to state as an ultimate fact that the law of the force in play between two molecules varies with the distance, that it is, for instance, attractive when they are far apart, repulsive when they are near together. Now, such a supposition is branded as artificial, but I venture to think that the artificiality is due rather to the acceptance of the hypothesis of action at a distance than to the assumed complication of the law. There are two closely related yet really distinct ways in which an apparent repulsive force may be (in the ordinary sense of the word) explained. It may, as has been the case with centrifugal force, be shown to be an effect of motion and inertia without any abandonment of the theory of action at a distance in the case of the other forces involved. Or it may be explained as a result of the properties of a medium by which matter is surrounded, or of which each atom is a specialised part. If action at a distance is thus reduced to action in proximity, if machinery is imagined adequate to account for the effects which distant bodies produce upon each other, it should explain not only the repulsions but also the attractions, not only molecular elasticity but gravitation.

It is, I believe, sometimes thought* that the next step in the progress of the theory of the constitution of matter will be the assumption of an unexplained attraction only between its ultimate particles, while their elasticity is otherwise accounted for. This explanation of elasticity may or may not involve the hypothesis of a medium extending between the molecules.

If we dispense with it, we must not be content with vague analogies to account for the behaviour of two molecules during an encounter. It is true that a comet coming out of space toward the solar system might and probably would travel round the sun without a collision, but in meteors (Swan) and in gases with non-repelling molecules collisions must take place, and Sir William Thomsom (*Rep. Brit. Ass.*, 1884, 616) has insisted on the fact that the result of such collisions in a gas must be the transformation of energy of translation into energy of vibration, with the spontaneous cooling of the gas as a result. It is precisely because no such effect is observed that the theory of elastic molecules is abandoned.

We are thus driven to suppose that elasticity is due to a repulsion, and, if we refuse to accept the theory of action at a distance, to introduce a medium by which the effect of a repulsion acting at a distance may be produced. It is, however, absurd to accept attraction at a distance, and to refuse to conceive of a repulsion acting under similar circumstances, to admit the one without explanation, and to invent a medium to account for the other. The most pregnant suggestions as to the constitution of matter which have hitherto been made do not proceed on these lines. An unexplained attraction is not assumed between vortex atoms in addition to the effects which follow from the laws of hydrodynamics. If it were necessary to adopt such an hypothesis, the vortex atom theory would evidently be as artificial as that embodied in the bald statement that the law of force changes with the distance from attraction to repulsion. It is perhaps possible that some such hybrid theory might serve as a useful basis for calculation, but from the philosophical standpoint it would not be a whit more conceivable than any other which involves action at a distance. If, then, we are to retain the language of the latter theory in any part of our discussion, it will be convenient and not less accurate to retain it throughout, on the distinct understanding that it is a conventional mode of representing facts which we do not fully understand, and which it does not suffice to explain completely. A better method of

* A Lecture delivered before the Chemical Society Feb. 2, 1888.

* "On the Law of Molecular Force," by W. Sutherland, *Phil. Mag.*, July, 1887, p. 127.

expression may be found when suggestions like the vortex-atom theory of Sir William Thomson and the granular theory of Prof. Osborne Reynolds (*Phil. Mag.*, December, 1885) are worked out. They, no doubt, will present grave difficulties as to the true nature of the action in proximity which takes place between contiguous granules, or between neighbouring layers of the ideal fluid in which the vortices are formed, but they will be justified as working hypotheses if they reduce the difficulties connected with the explanation of a large number of physical phenomena under a few heads.

If, then, we use provisionally the language of action at a distance in the expectation that it will ultimately be replaced by a theory of action in proximity, I think we ought, from the first, to admit that the law of force between molecules may be very complicated. We must not dismiss any idea which experiment suggests—such, for instance, as that there are several alternations of attraction and repulsion between two molecules as the distance between them diminishes—merely because it appears arbitrary and lacking in simplicity. It may be admitted, for the sake of argument, that we naturally look for simplicity in our fundamental assumptions; but if the machinery by which distant bodies affect each other, if the medium by which force is transmitted is simple, it by no means follows that its effects on matter can be expressed, on the action at a distance hypothesis by an easy formula. Even in the case of a single ball moving through a perfect liquid bounded by an infinite plane, it will be apparently attracted to or repelled by the boundary according as it is projected parallel to or towards it. In the vortex atom theory the behaviour of two molecules during an encounter would depend entirely upon the circumstances of the collision, and cannot be very shortly described. In the important case of a single vortex ring passing by a large number of others uniformly distributed, it will experience a repulsion.* In Prof. Osborne Reynolds's granular theory two molecules would exhibit mutual attraction and repulsion at different distances. In none of these cases can the fundamental assumptions be regarded as complicated, yet they all give rise to repulsions as well as attractions. They do not lead to simple expressions for the forces in play between molecules separated by distances of the same order of magnitude as the diameters. It would be perhaps too much to say that a simple result could only be produced by a medium of complicated constitutions, but it is certainly true that we have *à priori* no more right to expect simplicity in the results of its action than simplcity in its constitution, and that the two are not necessarily obtained together.

Thus much it has been needful to say in order to explain the point of view from which I wish to regard molecular forces in this lecture. I shall use the language of the action at a distance theory throughout, not—as I hope I have made clear—because I believe in it, but because, in so far as it can express them at all, it affords a self-consistent method of describing facts, the causes of which are as yet imperfectly understood. I shall not discuss the question of the representation of the forces by an algebraical formula. I cannot in the short time at my disposal exhaust the more limited subject to which I intend to confine myself. I desire only to lay before you an outline of the results of the principal experiments which have been made with the view of determining the distances through which a law of force apparently different to that of gravitation obtains. The greatest distance from a molecule at which this deviation is sensible is called "the radius of molecular action." It constitutes the superior limit to the range of molecular forces. The inferior limit is what is ordinarily called the radius of a molecule, but which, if we regard the molecules as exercising when in close proximity a mutual repulsion, is a length related to half the average minimum distance between their centres during an encounter.

This distance may depend on the temperature and on the physical state of the body, so that the diameter of a molecule may be different according as it is determined from experiments on gases or liquids. While retaining it as a convenient phrase, it will emphasize the conventional sense in which it is used if we speak of the diameter of a gaseous or liquid molecule, as the case may be.

Between the limits thus defined the law of force is unknown, though interesting suggestions have been made by Maxwell and others; but apart from this question, which, as I have said, I do not now discuss, the limits themselves may be determined very differently by different methods. The question as to whether a molecular force is "sensible" at a given distance from the molecule, depends partly upon the sensitiveness of the means used to detect it, and partly upon the nature of the phenomenon—electrical, optical, or otherwise—studied. It is impossible, therefore, to group the results of various observations into a connected whole, but it may nevertheless be useful to give a short *résumé* of the conclusions to which different observers have been led, and to attempt to arrange them, as far as may be, in order.

The largest values which have been obtained for the magnitude of the radius of molecular action have been deduced from observations on the condensation of films of gases and vapours on the surfaces of solids. Quincke (*Pog. Ann.*, cviii., 326, 1859) in 1859 argued that if it be assumed that the law of molecular force is the same for molecules in the gaseous, liquid, and solid states, the superior specific gravity of a solid would enable it to condense a gas upon its surface.

It is evident, however, from recent observations, that the nature of the solid is of even greater importance than its density. Among the more remarkable investigations on this point is that of Bunsen (*Wied. Ann.*, xx., 552, 1883). A bundle of glass threads, the total surface of which was determined by preliminary observations and calculations, was enclosed in a chamber connected with a long tube, the lower end of which was dipped in mercury. The gradual rise of the mercurial column showed that an apparent absorption of carbonic acid by the glass was still going on at the end of three years. Later observations (*Wied. Ann.*, xxiv., 1885, 322) proved that although the glass had been carefully dried, it is impossible to get rid of all the adhering moisture, unless the temperature is raised to a point not far short of the critical temperature of water. If this precaution has been omitted, carbonic acid, if present, will, according to Bunsen, be dissolved in the water-film, and since the inner layers of the liquid are subjected by molecular attraction to a pressure which is measured by hundreds of atmospheres, they are capable of absorbing enormous quantities of the gas. The strong acid thus formed appears to attack the glass, and it was found that nearly 6 per cent of the total mass of glass threads employed had been disintegrated (*Wied. Ann.*, xxix., 1886, 161). The long-continued apparent condensation was therefore really slow chemical action. Nay, more, when the glass had been dried at a high temperature, no appreciable condensations of carbonic acid on the surface took place in eight days (*Wied. Ann.*, xxiv., 1885, 335). A small quantity of water was then introduced and absorbed by the glass threads with a rapidity which showed that when really dry they acted as a more powerful desiccator than calcium chloride. Immediately after the introduction of the water the absorption of the CO_2 began as before, which proved that moisture was necessary to produce the phenomenon, or that carbonic acid does not condense to a measurable amount on dry glass.

By exposing glass threads to a series of constant temperatures until in each case no more moisture could be extracted by the passage of a current of dry air over them, and by measuring the successive quantities of water

* "Motion of Vortex Rings," J. J. Thomson. Macmillan, 1883, p. 55.

thus obtained, Bunsen was able to calculate the total thickness of the water film, which at each of these temperatures is irremovable by dry air. Under ordinary conditions water does not evaporate when its vapour exerts upon the surface a particular pressure, the magnitude of which varies with the temperature. Any internal layer parallel to the surface is subjected to an additional molecular pressure which increases rapidly with the depth, until the boundary of the superficial portion of the liquid is reached, after which it becomes throughout the interior constant.

If the interior mass of water be replaced by a solid which exerts, *cæteris paribus*, a greater attraction on water than that of water itself, the molecular pressure would be increased, and thus the vapour-tension might be diminished without evaporation taking place. The defect of the external pressure would be balanced by the increased molecular attraction. If, then, we assume that the thickness of the water film which cannot at any given temperature be removed by dry air is such that the pressure due to molecular attraction at the surface of the film is equal to the pressure of aqueous vapour at the temperature at which the experiment is made, it is possible when the vapour-tension is known to calculate the molecular pressure for given thicknesses of the film. The following table expresses Bunsen's results. The temperature is expressed in degrees centigrade. The thickness, neglecting some minor corrections, is indicated by D, and expressed in terms of micromillimetres ($\mu.\mu.$)* The pressure is expressed in atmospheres :—

t.	D.	*p.*
23°	10·52	0·027
107	6·70	1·278
215	5·47	20·791
329	3·63	—
415	1·32	—
468	0·42	—
503	0·00	—

If the desiccation with dry air was incomplete the thickness of the films very much exceeded the above limits. Thus in one experiment, in which the drying was purposely imperfect, the water layer was 232·4 $\mu.\mu.$ thick. The interpretation to be placed on these results has, however, been again rendered doubtful by the experiments of Warburg and Ihmori (*Wied. Ann.*, xxvii., 481, 1886). These observers constructed a small balance of extraordinary delicacy, which was enclosed in an exhausted receiver, which could be connected at pleasure with vessels containing strong H_2SO_4 or water. When it had been dried by frequent evacuation, water vapour was admitted, and the weight of the films deposited on a thin glass bulb suspended from the balance was determined. They found that if before the experiment the glass was washed with boiling water, the deposited film was very much thinner than if this precaution was omitted. The thickness diminished in two experiments in the proportion of 48 to 4 and 23 to 2. In a third case no film could be detected even when the temperature of the receiver was only 0·2° above the dew point.

Glass rods which have been boiled for a few minutes will not discharge an electroscope, even when they have for long been in a relatively damp atmosphere, under circumstances such that rods of the same glass which have not been similarly treated conduct readily.

The film of moisture adherent to glass may thus be divided into two parts, distinguished as the permanent and temporary respectively, of which the latter disappears under the influence of a long-continued current of dry air, while the former can only be removed by raising the temperature. Warburg and Ihmori conclude that the temporary film (with which they alone deal) is not produced by the molecular attraction of the glass as a whole on water vapour. They refer to experiments which prove that if glass powder be boiled in water measurable quantities of alkali are dissolved. They therefore assume that there is a certain quantity of free or loosely combined alkali on the surface of the glass, and that it absorbs water until a solution is formed, the vapour-tension of which corresponds to the hygrometric state of the air in the neighbourhood. If carbonic acid is then absorbed by the solution, the glass may be attacked and the process continued.

(To be continued).

* The micromillimetre is the millionth part of a millimetre.

METHODS OF MILK ANALYSIS.*

Estimation of Water.

From a weighing bottle take 5 c.c. milk, put in a weighed thin glass dish, or dish lined with tinfoil, one-third full of powdered asbestos; dry for two hours at 100° C. The temperature obtained in a boiling water-bath does not reach 100° C. The milk should be dried in an air-bath, the temperature of which is carefully controlled.

Alternate Method of Estimating Water.

Evaporate one or two grms. of milk in shallow watch glass or platinum dish on the water-bath for thirty minutes. Dry for an hour at 100° C. and weigh.

Estimation of Casein.

Take 5 grms. of milk, digest in Kjeldahl apparatus, with 20 c.c. H_2SO_4, and estimate ammonia in the usual way.

Alternate Method of Estimation of Casein.

Rub up in a mortar the thin dish containing the dried residue from the above process or remove the foil containing it, and transfer to soda-lime combustion tube in the usual way.

The mortar and pestle must be well cleaned with the soda-lime and these cleanings placed in the tube.

Or the dish or tinfoil and its contents may be transferred to a digestion flask and the casein estimated by the method of Kjeldahl.

Estimation of Fat.

Method of Adams.—The kind of paper and the method of using it first proposed by Adams are as follows :—

"As for material, the only extra article is some stout white blotting-paper, known in the trade as 'white demy blotting mill 428,' weighing 38 pounds per ream. This should be in unfolded sheets, machine-cut into strips 2½ inches wide and 22 inches long; each sheet in this manner cuts into seven strips.

"I have tried other papers, but none have answered so well as this; it is very porous and just thick enough. Each of these strips is carefully rolled into a helical coil, for which purpose I use a little machine, made by myself, consisting of a stout double wire, cranked twice at right angles, and mounted in a simple frame. One end of the strip being thrust between the two wires, the handle is turned, and the coil made with great facility. This may be done, for the nonce, on a glass rod, the size of a cedar pencil. Two points have to be carefully attended to: the paper must not be broken, and the coil must be somewhat loose, the finished diameter being a little under an inch. I am in the habit of rolling up a considerable number at a time and placing each within a brass ring as it is rolled, inscribing on one corner with a lead-pencil its own proper number.

"These coils are next thoroughly dried, and I need hardly say the accuracy of the process depends upon this drying. This can be satisfactorily done in an ordinary air-bath at 100° C., providing the bath be heated properly

* Official Methods of Analysis of the Association of Official Agricultural Chemists for 1887-88. U.S. Department of Agriculture, Division of Chemistry.

and the paper kept in it long enough. I found the common way of heating the thin bottom of the bath with a single jet not to answer. My bath is placed upon a stout iron surface, which is heated by a large ring of jets; in this way the heat is evenly distributed over the whole of the bottom of the bath, and the papers, which are put in a cage frame of tinned iron wire 5 by 2½ inches and divided into eight partitions, get evenly and completely dried, if allowed to remain in the bath all night, and weighed in a weighing tube next morning, and their weights having been registered according to their numbers, stored away ready for use, as follows:—

"The milk to be examined is shaken, and with a pipette 5 c.c. are discharged into a small beaker 2 inches high by 1¼ diameter, of a capacity of about 30 c.c. weighing about 12 grms. This charged beaker is first weighed, and then a paper coil gently thrust into the milk very nearly to the bottom. In a few minutes the paper sucks up nearly the whole of the milk. The paper is then carefully withdrawn by the dry extremity of the coil and gently reversed, and stood, dry end downwards, on a clean sheet of glass. With a little dexterity all but the last fraction of a drop can be removed from the beaker and got on the paper. The beaker is again weighed, and the milk taken got by difference. It is of importance to take up the whole of the milk from the beaker, as I am disposed to consider the paper has a selective action, removing the watery constituents of the milk by preference over the fat.

"The charged paper is next placed in the water oven on the glass plate milk-end upwards, and rough-dried. Mismanagement may possibly cause a drop to pass down through the coil on to the glass. This accident ought never to occur; but if it does, it is revealed in a moment by inspection of the surface of the glass, and the experiment is thereby lost.

"In about an hour it is rough-dried and in a suitable condition for the extraction of the fat."

The method of Adams has been thoroughly tried by the English chemists, and has received the approval of the English Society of Public Analysts. It gives uniformly about 0·2 per cent more fat in normal milk than the ordinary gravimetric methods.

The following modification of the process may be used:—

"The blotting-paper is replaced by thick filtering paper cut into strips 2 feet long and 2·5 inches wide. These are thoroughly extracted by ether or petroleum ether (or alcohol).

"One end of the strip of paper being held horizontally by a clamp or by an assistant, 5 c.c. milk is run out by a pipette from a weighing bottle along the middle of the strip of filtering paper, being careful not to let the milk get too near the ends of the paper, and to secure an even distribution of it over the whole length of the slip. The pipette is replaced in the weighing bottle and the whole re-weighed, and thus the quantity of milk taken is accurately determined. The strip of paper is now hung up over a sand-bath in an inclosed space high enough to receive it where the air has a temperature of 100° C. (*circa*). In two or three minutes the paper is thoroughly dry. It is at once, while still hot, rolled into a coil and placed, before cooling, in the extraction apparatus already described.

"The fat is dissolved by ether or petroleum, collected in a weighed flask, and, after thorough drying, weighed."

The fat after extraction may also be estimated volumetrically, as described in the method of Morse.

From data which have been collected it appears that the estimation of the fat in milk by the lactrocrite is strictly comparable with the results of the Adams method. Those who have this instrument, therefore, can use it instead of the method given.

Alternate Method of Estimating the Fat in Milk.

Method of Morse, Piggot, and Burton.—This method consists in the dehydration of the milk by means of anhydrous sulphate of copper; the extraction of the fat by means of the low-boiling products of petroleum; the saponification of the butter by means of an excess of a standard solution of potassium hydroxide in alcohol; and the determination of the excess of the alkali by means of a solution of hydrochloric acid. The following apparatus and reagents are required:—

(1) A porcelain mortar and pestle.

(2) An extraction tube, 14 or 15 m.m. in diameter, 220 m.m. in length, with funnel-shaped top. A straight chloride of calcium tube may be used for this.

(3) A 200 c.c. Erlenmeyer flask, strong enough to be used with a filter-pump.

(4) A suitable stand for holding the flask and extraction tube.

(5) Ten c.c. pipettes.

(6) Weighing-glasses with ground-glass stoppers.

(7) A low-boiling gasoline, distilling between 30° and 60°.

(8) Dehydrated sulphate of copper.

(9) Semi-normal solution of potash in 95 per cent alcohol.

(10) A semi-normal solution of hydrochloric acid.

Manipulation.—Place about 20 grms. of the anhydrous copper sulphate, roughly measured in a copper spoon of the size to hold about that amount, in a porcelain mortar; make a cavity in the centre of the mass with the pestle. Allow 10 c.c. of the milk to run on to the copper sulphate, being careful that none of it touches the sides of the mortar. When the milk is nearly dry, grind the mass up with a little clean sand, transfer to the extraction tube, gently pressing it down in the tube by means of a glass rod. The lower portion of the extraction tube to be packed with clean cotton-wool. The fat is extracted in the following way:—15 c.c. of benzine are poured over the material in the extraction tube and drawn down with the aid of the filter-pump, until the whole of the mass to be extracted has become wet with the liquid, when the connection with the pump is closed; after about five minutes another portion of 15 c.c. of benzine is poured into the tube, and the whole of the liquid slowly drawn through with aid of the pump into the flask. Usually one extraction of this kind is sufficient to withdraw the whole of the butter, but for the sake of greater accuracy the process may be repeated two or three times.

Titration.—The benzine may be evaporated and the residual butter fat saponified with about 25 c.c. of the approximately semi-normal potash. The residual alkali is determined by means of the semi-normal hydrochloric acid, using phenol-phthalein as indicator. The difference between the amount required in this process and the amount necessary to neutralise the quantity of alkali taken gives the amount of alkali required for the saponification. The number of milligrms. of potash required for one grm. of the fat is taken at 230. The fat may also be accurately titrated without evaporating the benzine.

Alternate Method of Estimating Water and Fat in Milk.

Method of Babcock.—In the bottom of a perforated test-tube is placed a clump of clean cotton; the tube is then filled three-quarters full of ignited asbestos, lightly packed, and a plug of cotton inserted over it. The tube and contents are weighed and the plug of cotton carefully removed, and 5 grms. of milk from a weighed pipette run into it, and the plug of cotton replaced. The tube connected at its lower end by a rubber tube and adapter with a filter-pump is placed in a drying oven of a 100° C., and a slow current of dry air drawn through it until the water is completely expelled, which in no case requires more than two hours.

The tube containing the solids from the above operation is placed in an extraction apparatus and exhausted with ether in the usual way.

Alternate Method of Estimating Water and Fat.

Method of Professor Macfarlane.—A glass tube 4 to 5 c.c. in length and 2 c.m. in diameter, open at one end,

drawn out to a tube 5 m.m. in diameter at the other end, is two-thirds filled with asbestos fibre, such as is used in manufacturing packing. It is dried in the water-bath for several hours, cooled in the desiccator, and weighed. Ten c.c. of the milk is then added from a pipette, which is completely absorbed by the asbestos. It is then weighed, the additional weight of the milk representing the amount taken. The tube, along with many others, is placed in a water-bath with constant level and dried for ten or twelve hours (during the night) at a temperature of 90°. Next morning the tubes are cooled in the desiccator and weighed, the loss in weight being the moisture. The tubes are then placed in the Soxhlet extraction apparatus and exhausted with petroleum ether for four hours. They are then removed and dried in a steam-bath, cooled in desiccator, and weighed. The loss represents the butter fat.

The Estimation of Sugar.

The reagents, apparatus, and manipulation necessary to give the most reliable results in milk-sugar estimation are as follows :—

Reagents.—(1) *Basic plumbic acetate*, sp. gr. 1·97. Boil a saturated solution of sugar of lead with an excess of litharge, and make it of the strength indicated above. One c.c. of this will precipitate the albumens in 50 to 60 c.c. of milk.

(2) *Acid Mercuric Nitrate.* Dissolve mercury in double its weight of nitric acid, sp. gr. 1·42. Add to the solution an equal volume of water. One c.c. of this reagent is sufficient for the quantity of milk mentioned above. Larger quantities can be used without affecting the results of polarisation.

(3) *Mercuric Iodide with Acetic Acid.* KI 33·2 grms., $HgCl_2$ 13·5 grms., H, C_2H_3O 20 c.c., H_2O 64 c.c.

Apparatus.—(1) Pipettes marked at 59·5, 60, and 60·5 c.c. (2) Sugar flasks marked at 102·4 c.c. (3) Filters, observation tubes, and polariscope. (4) Specific gravity spindle and cylinder. (5) Thermometers.

Manipulation.—(1) The room and milk should be kept at a constant temperature. It is not important that the temperature should be any given degree. The work can be carried on equally well at 15° C., 20° C., or 25° C. The slight variations in rotatory power within the above limits will not affect the result for analytical purposes. The temperature selected should be the one which is most easily kept constant.

(2) The specific gravity of the milk is determined. For general work this is done by a delicate specific gravity spindle. Where greater accuracy is required use specific gravity flask.

(3) If the specific gravity be 1·026, or nearly so, measure out 60·5 c.c. into the sugar flask. Add 1 c.c. of mercuric nitrate solution or 30 c.c. mercuric iodide solution and fill to 100·4 c.c. mark. The precipitated albumen occupies a volume of about 2·44 c.c. Hence the milk solution is really 100 c.c. If the specific gravity is 1·030 use 60 c.c. of milk. If specific gravity is 1·034 use 59·5 c.c. of milk.

(4) Fill up to mark in 102·4 c.c. flask, shake well, filter, and polarise.

Notes.—In the above method of analysis the specific rotatory power of milk sugar is taken at 52·5, and the weight of it in 100 c.c. solution to read 100 degrees in the cane-sugar scale at 20·56 grms. This is for instruments requiring 16·19 grms. sucrose to produce a rotation of 100 sugar degrees. It will be easy to calculate the number for milk-sugar whatever instrument is employed.

Since the quantity of milk taken is three times 20·56 grms., the polariscopic readings divided by 3 give at once the percentage of milk-sugar when a 200 m.m. tube is used.

If a 400 m.m. tube is employed, divide reading by 6; if a 500 m.m. tube is used divide by 7·5.

Since it requires but little more time, it is advisable to make the analysis in duplicate, and take four readings for each tube. By following this method gross errors of observation are detected and avoided.

By using a flask graduated at 102·4 for 60 c.c. no correction for volume of precipitated casein need be made. In no case is it necessary to heat the sample before polarising.

In the above method no account is taken of the fat which is retained on the filter with the casein. It is worth while to enquire if a correction similar to that made for the abumenoids should not also be made for the fat ?

Estimation of Ash.

Evaporate to dryness in a weighed platinum dish 20 c.c. of milk from a weighing bottle, to which 6 c.c. of HNO_3 has been added, and burn in a muffle at low red heat until ash is free from carbon.

NOTICES OF BOOKS.

Management of Accumulators and Private Light Installations. A Practical Handbook. By Sir David Salomons, Bart., M.A., M.S.T.E. Third Edition, Revised and Enlarged. London: Whittaker and Co., Paternoster Square.

The two earlier editions of this work seem to have been issued under another title. The subject-matter of the present edition has been re-written so as to bring the subject down to date.

The work consists of two parts. The first, dealing with cells, describes their mode of employment, the setting up of the battery and the management of the accumulator-house, the processes of charging and discharging, the causes of failures and their remedies, followed by a general summary.

The second part is devoted to installation work and practice, and includes sections on dynamos, engines and electrical-motors, switch-boards, switches, instruments, lamps and wiring, the action of cells with the dynamo, methods of working and governors, estimates of the expense necessary for electric lighting, and, lastly, an account of the installation at the author's residence. We notice one remark not easy to understand :—"If the engine-house is made totally inflammable there is no necessity to insure against fire."

We find that at the author's mansion the cost of the electric light was at the rate of 2*d.* per hour for every 16-candle power lamp. In 1885 the cost was reduced to $1\frac{1}{4}$*d.* per hour, and in 1886 $\frac{3}{7}$*d.* per hour, for each lamp of the same power. In this year the electric light proved therefore cheaper than gas, supposing it to be sold at 3*s.* 6*d.* per 1000 cubic feet. The first outlay is considerable, and for a small house, not connected with any public supply of electric energy, would be simply prohibitive. But for large manufacturing establisments the estimates here given will prove a valuable guide. The "Management of Accumulators" will prove exceedingly useful for persons who contemplate erecting an electric light installation for their own premises.

CORRESPONDENCE.

INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—Mr. Lovett has been for some years a Fellow of the Institute, and it is to be presumed has in his possession some, if not all, of the numerous presidential addresses which have been printed and circulated. A perusal of these should have given him the information he asks me to supply, but if, considering these out of date, he will

wait for a few days, he will have a most lucid treatise on the aims and intentions, hopes and aspirations, of our body, in the shape of the admirable address read by Dr. Odling on Thursday last.

In my opinion the Institute has already achieved a work of immense value not only to the profession as a whole, whether within or without its bounds, but to the nation, inasmuch as it has given the science, as applied to the practical needs of life, a corporate existence, a voice, and the means of making its voice heard.

This is now an accomplished fact; in place of a scattered and unrecognised body—a sort of poor relations of the medical men, not even on a level with pharmacists, and immeasurably below engineers or architects in public estimation—there has come into being a compact, organised, and comparatively wealthy corporation, recognised by the Government, and able and willing to make its influence felt in the world.

Surely we should be content with so much effected in eleven years (most of us thought twenty not too much to allow for the work) and not let ourselves, simply because things are tranquil, be bitten with that spirit of "*must do something*," which Herbert Spencer has indicated as the cause of so many miscarriages of well-intentioned effort.

Above all, we should seek for advance in general service for the common good, and keep in the background as much as we can that question of "What do I, Smith, get for my guinea to distinguish me from Robinson, who keeps his in his pocket?" For those who adopt this attitude a sufficient answer is: "The self-glorification consequent upon permission to use the letters F.I.C.!" I am, &c.,

R. J. Friswell.

115, Darenth Road, N.,
March 4, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 7, February 13, 1888.

An Ancient Process for Rendering Jewels and Vitrifications Phosphorescent.— M. Berthelot.—The collection of the Greek alchemists found in certain MSS. of the 13th and 15th centuries in the National Library, describes processes used for the artificial colouration of factitious jewels, emeralds, carbuncles, and hyacinths. Stones were to be made luminous in the night by dyeing them with a mixture of copper rust and of the gall of the tortoise. A finer colour was obtained by using the sea medusa instead of the tortoise. This colouration was of course not permanent, but it was easily reproduced.

In What Degree of Oxidation are Chrome and Manganese in their Fluorescent Compounds.—Lecoq de Boisbaudran.—The author does does not answer this question.

The Absorbent Power of Soils in the Formation of Native Sodium Carbonates.—Paul de Mondesir.—Berthollet's explanation of the formation of soda in as far as common salt yields the soda and calcium carbonate the carbonic acid. But the reaction occurs in two stages; in the former the soil reacts upon the sodium chloride, converts it into calcium chloride by giving it lime and absorbing soda. In the second phase, which sets in only after the removal of the calcium chloride, the calcium bicarbonate and the carbonic acid cause soda to issue from the earth by giving lime to the latter. Sodium carbonate is produced in all permeable calcareous soils according to the quantity of sodium chloride which they receive.

On Chemical Equilibria.—P. Duhem.—The author shows that the conclusion of a memoir by M. Le Chatelier (*Comptes Rendus*, cvi., p. 355) is anticipated in his paper to be found in the *Comptes Rendus* (xcix., p. 1113).

The Mineralising Action of Alkaline Sulphides: Reproduction of Cymophane. — P. Hautefeuille and A. Perrey.—By this agency the authors have effected the crystallisation of glucina, its separation from alumina, or, inversely, the reproduction of the aluminate of glucina, a compound met with in Nature, and known as cymophane.

Displacement of Copper by Zinc in certain Solutions of the Copper Salts.—A. Destrem.—If copper is thrown down from its solutions by means of a slip of pure, clean zinc, the deposit varies in colour according to the salt of copper present. With the sulphate and nitrate the deposit is slightly adhesive, pulverulent, and of a maroon or blackish colour. In slightly alkaline solutions, such as ammonium cupro-sulphate, the deposit is red and perfectly adhesive. In the salts of the weaker acids the coating is of a brassy yellow, and strongly adhesive. In neutral or slightly alkaline solutions there are formed, at the outset, alloys possessing the composition of brasses. Similar phenomena are observed with cadmium.

The Splitting-up of Chloroform by Alcoholic Potassa, and its Determination by means of this Reaction.—L. de Saint-Marten.—Potassa dissolved in alcohol, of 60 per cent, at the temperature of 100°, completely splits up chloroform into potassium formiate and chloride. The quantity of chloroform originally present is deduced from the chlorine.

Zeitschrift fur Analytische Chemie.
Vol. xxvi., Part 3.

Dryness of Walls, &c.—J. Nessler.—The author lays a very thin slip of gelatin against the object. If this is not thoroughly air-dry the gelatin becomes curved, with its convexity towards the object.—(*Chemiker Zeitung*).

Presence of Soluble "Weighting" Ingredients in Leather.— B. Kohnstein.— The author takes 20 to 25 grms. of the sample, finely shred, determines moisture at 100°, lixiviates three or four times with lukewarm water until the extracts no longer appear coloured, filters, and makes up the total extract to ½ litre. Of this liquid 100 c.c. are evaporated down and the dried residue is weighed. This shows the sum of all extracted matters, tannin, colouring-matters, gallic acid, and other extractive matters of the tanning agents, and if present, sugar, dextrine, and extractive substances from the weighting materials. This residue is incinerated. To determine tannin, colouring-matter, and gallic acid, 200 c.c. of the extract are mixed with 6 grms. of recently ignited magnesium oxide and let stand, shaking frequently, until the clear liquid no longer reacts either with iron or glue. In this manner the tannin, colouring-matter, and gallic acid are precipitated, everything else remaining in solution. The liquid is filtered, an aliquot part of the clear filtrate is evaporated to dryness, weighed, and the amount of ash determined. The difference between the former percentage of dry matter free from ash and this latter result shows the total percentage of tannin, colouring-matter, and gallic acid.

Determination of the Decolourising Power of Bone-black.—G. Laube.—Five grms. of normal black are heated to a boil in a capacious flask with 200 c.c. of water, 10 c.c. of colour solution are added, and the whole is kept at a gentle boil for ten minutes, preventing the loss of water by means of a reflux condenser. The liquid is then at once filtered through a double folded filter. We then add to 200 c.c. of water, colour solution from a measuring pipette until the liquid has exactly the same tint as the above filtrate. If 2·1 c.c. of colour solution

have been used in one experiment 10 − 2·1 = 7·9 c.c. of colour solution have been absorbed by the standard bone-black. The sample to be tested is then treated in a similar manner. The standard and the sample must both be sifted through a sieve of the same fineness.

Determination of Rich Copper Ores.—E. Donath and R. Jeller.—A portion of the ore in fine powder is thoroughly mixed in a porcelain capsule with twice its volume of zinc-powder, and then ignited for ten minutes in a covered crucible. The contents are then boiled in a small beaker in an excess of dilute sulphuric acid (1 part acid with 3 to 4 parts water), when the zinc sulphide, the excess of zinc, and the reduced iron dissolve. The copper remains as such accompanied by the gangue, and any metals precipitable by zinc. After washing the copper sponge by decantation with hot water it is dissolved in dilute nitric acid with the aid of heat, the gangue is filtered off, and an aliquot part of the solution is titrated with potassium cyanide in an ammoniacal solution.

Simplified Method for Determining Carbon in Arable Soil.—G. Gustavson.—About 5 grms. soil are put in a platinum boat and introduced into a tube of sparingly fusible glass 50 c.m. in length; the other part of the tube receives a layer of scaly copper oxide 10 c.m. in length, between asbestos plugs. This part of the tube is enfolded in copper-wire gauze and heated by a burner. The organic matter is slowly burnt in the current of oxygen by means of a second burner. The boat must be heated slowly at the beginning of the operation. The sulphuric acid through which the gases pass must remain colourless, and the carbonic acid is collected in the ordinary manner.

Rapid Examination of Alloys of Lead and Tin.—Fœhr.—The proportions of the metals are calculated from the specific gravity of the alloy by means of a table which the author has drawn up.

Impurity in Chloroform. — L. Scholvein. — The author found in several cases an impurity of arsenic present, apparently derived from impure arsenical sulphuric acid used in the purification of the chloroform.

Valuation of Coca Leaves.— Kœhler. — From the *Pharmaceutische Zeitung*.

Detection of Codeine in Morphine Hydrochlorate.—H. Hager.—0·1 grm. of the sample is dissolved in 2 c.c. of water; 3 drops of the warm solution are placed upon a large object glass and spread out to the size of a shilling. In the centre of this is placed a drop of soda-lye of sp. gr. 1·16, when a turbidity occurs in from one to five seconds. For the detection of narcotine Hager proceeds as above, but adds 5 or 6 drops of soda-lye and stirs up with a glass rod. If only codeine is present as an impurity the mixture remains clear and transparent, but if narcotine is present a white turbidity is at once formed and does not disappear.

Determination of Oxalic Acid in Urine.—O. Nickel.—Neither the method of Schultzen and Neubauer nor any of its many modifications can be considered satisfactory.

New Apparatus for Determining Urea with Bromine-water.—C. Frutiger.—This apparatus cannot be intelligible described without the accompanying cut.

Determination of Creatinine in Urine.—P. Grocco.—The author makes use of Neubauer's process. To prevent the conversion of creatinine into creatine he keeps the sample in ice and adds acetic acid.

Determination of Hippuric Acid in Urine. — O. Völker.—For the author's process we must refer to the original.

The Application of the Sugar Tests of Molisch to Urine.—A controversy between Molisch and Seegen.

Determination of Sugar in Diabetic Urine and the Reductive Power of Normal Urine.—J. Munk.—The reductive value of normal human urine equals, on an average, 0·3 per cent of sugar. The use of carbohydrates does not affect the proportion.

Detection of Phenol.—Dragendorff.—In toxicological cases the author, instead of distilling with sulphuric acid, shakes the mixture out with petroleum ether.

Behaviour of Thalline and Antipyrine.—E. Blumenbach.—The author describes the methods of extracting these bases from mixtures and organs, and their most available tests.

The Atomic Weight of Antimony.—F. Pfeiffer and A. Popper.—These authors have proceeded by the electrolysis of a solution of antimonious chloride, and have obtained the values 120·72, 120·82, and 120·54, figures which are a unit higher than the value found by Cooke.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. Series 4, Vol. ii., No. 23, Nov., 1887.

Inauguration of the Statue of Nicolas Leblanc.—This ceremony took place on June 28th last, when discourses in honour of the deceased inventor were pronounced by M. E. Peligot, representing the Academy of Sciences, by the Minister of Commerce and Industry, and by Colonel Laussedat.

On Sewage.—Dr. Meymott Tidy.—A discourse delivered before the Chemical Society.

No. 24, December, 1887.

Copper Assays in the Mineral Market.—Mr. Westmoreland.

Improvement in the Manufacture of Sodium.—J. Mactear.—Both these papers are from the *Journal of the Society of Chemical Industry*.

Revue Universelle des Mines et de la Metallurgie. Series 3, Vol. i., No. 1, January, 1888.

This issue contains no chemical matter.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Bleaching Soft Soap.—Can a soft soap be bleached, or is it possible to make a white soft soap; and if so, how is it made, and should I infringe a patent by making it?—T. R.

MEETINGS FOR THE WEEK.

MONDAY, 12th.—Medical, 8.30.
— Society of Arts, 8. "Alloys," by Prof. W. Chandler Roberts-Austen, F.R.S.

TUESDAY, 13th.—Royal Medical and Chirurgical, 8.30.
— Institution of Civil Engineers, 8.
— Photographic, 8.
— Royal Institution, 3. "Before and After Darwin," by George John Romanes, F.R.S.

WEDNESDAY, 14th.—Geological, 8.
— Microscopical, 8.
— Pharmaceutical, 8.
— Society of Arts, 8. "Agricultural Education and Dairy Instruction," by Professor John Wrightson.

THURSDAY, 15th.—Royal, 4.30.
— Royal Institution, 3. "Microscopical Work with Recent Lenses on the Least and Simplest Forms of Life," by The Rev. W. H. Dallinger, LL.D., F.R.S.
— Chemical, 8. Ballot for the Election of Fellows. "The Nature of Solution as Elucidated by the Heat Evolved on Diluting Solutions. Part. I: Calcium Chloride."

FRIDAY, 16th.—Society of Arts, 8. "The Origin, Progress, and Influence of Universities in India," by F. J. Mouat, M.D.
— Royal Institution, 9 "The Structure, Origin, and Distribution of Coral Reefs and Islands," by John Murray.

SATURDAY, 17th.—Royal Institution, 3. "The Modern Drama: Scandinavian," by William Archer.
— Society of Arts, 8. "Protection of Buildings from Lightning," by Professor J. Oliver Lodge.

THE CHEMICAL NEWS.

Vol. LVII. No. 1477.

ON THE

DETERMINATION OF THE AMOUNT OF MORPHIA PRESENT IN OPIUM.

By E. F. TESCHEMACHER and J. DENHAM SMITH.

(Concluded from p. 95).

We think it useless to pass in review any more of these methods of dealing with opium, for until my late friend and partner, Edward Teschemacher, had devised his method, the writer had habitually declined undertaking opiums, for the best of all reasons—that he knew no method of estimating the morphia they might contain which could be relied on.

It would be, on very many accounts, most objectionable were we to pass unnoticed the important process of the *British Pharmacopœia*. We have not the first edition (1867), although we find in Mr. Squire's "Companion to the British Pharmacopœia" (pp. 224-5, ed. 13th) a full description of the process for estimating the morphia in opium; and this we have followed with great exactness, using an opium we have frequently employed in this research, yieding to us 11·20 per cent of morphia, and obtaining by this method of the *British Pharmacopœia* 2¾ and 3¾ per cent of morphia for the results of two experiments. We should have further investigated this matter had we not found that the process had been superseded in the more recent edition of 1885, convincing us that the former mode had been found to be faulty, and so withdrawn.

This brings us to the article "Opium," pp. 295-7 of the *Brit. Pharm.* (1885). We have been tempted to criticise this article apart from the process for the determination of morphia,—a temptation we have resisted as foreign to the immediate object of this pamphlet, although we shall be forced to indulge in some few remarks which are germane to the process.

Process.—Triturate together 140 grains of dry opium, 60 grains of slaked lime, and 400 grains of water until a uniform mixture results. Then add 1000 more grains of distilled water, stirring occasionally during half an hour. Now "filter this mixture into a wide-mouthed 6 oz. bottle marked at exactly 1040 grains, until it reaches this mark. To the filtered liquid (representing 100 grains of opium) add 110 grains of rectified spirit and 500 of ether, shake the mixture, and then add the chloride of ammonium"; with further instructions most minutely detailed, concluding with the "crystals, morphia, should not weigh less than 9½ grains and not more than 10½ grains, corresponding to about 10 per cent of morphia in the dry opium." This formula presented great difficulties to us who wished to follow it with absolute exactness. Why 1040 grains of the liquid were to be regarded as equal to 100 grains of opium instead of 1000 grains of the filtrate we could not then, nor can we yet, understand. Then, as we could not pretend to use, with any hope of exactness, such a measure as "a 6-oz. wide-mouthed bottle marked exactly at 1040 measured grains," we fell back on our usual apparatus for this purpose.

This process of the *British Pharmacopœia* of 1885 is, in our view, by far the most important to the dealers in opium in this kingdom of any of the processes for determining the morphia present in opium we have considered or met with. It comes to us claiming respect, and seemingly entitled to exact it. The *Brit. Pharm.* is stamped "By Authority." "Pursuant to the Medical Act, 1858." It has been compiled by three editors, who are professors to boot, seemingly with the guidance and sanction of physicians of rank and standing. Thus it may claim to possess legal authority also, and be appealed to, on any question which may arise connected with the subject of which it treats, and its authority accepted by a Court of Law as determining, and determining finally, any such question. Thus, whilst compelled to point out some two or three questionable directions in this opium process of the *Brit. Pharm.*, we have followed its directions when possible,—as in taking 1040 fluid grains of the filtrate, and only declining its somewhat rude apparatus for measuring these, as it did not admit of being used twice successfully, if ever.

We have employed this method in six different trials, with the subjoined results, using an opium constantly giving us 11·20 per cent of morphia.

No. 1	yielded	9·60	per cent of	morphia.
2	,,	10·50	,,	,,
3	,,	9·60	,,	,,
4	,,	9·60	,,	,,
5	,,	9·40	,,	,,
6	,,	9·40	,,	,,

Experiment "No. 2, 10·50 per cent of morphia," is the only doubtful result. No approximation to this occurred in either of the four subsequent tests, and thus we incline to assign this one to some error of analysis, and dismiss it from consideration as usual in such cases.

The crushing conclusion remains that a process which ought to be trustworthy signally fails when put to the proof by probably the most practised hands in the kingdom. It has yielded 9·40 to 9·60 per cent of morphia with an opium which has, over and over again, afforded us 11·20 per cent. Moreover, whilst we are very sure that our 11·20 per cent is pure morphia, we have no such conviction, but rather grave doubts, whether the *Pharmacopœia* method yields, or is expected to yield, pure morphia. If so, whence that odd provision of a margin of "9½ to 10½ grains"?—*i.e.*, a difference of some 10 per cent in the results, permitted, probably expected.

We have not seen the Medical Act of 1858, but we should be amazed to find that such a matter as this opium process was an instruction therein, and therefore, if it were not requisite, we are still more amazed to find that a triple editorial staff did not suffice to cancel an imperfect process and suppress it altogether. Here the Squibb law, that results may be obtained "almost exactly comparable among themselves," is again true, five tests yielding from 9·40 to 9·60 per cent of morphia, so that a faulty method, involving grave sources of error, is adopted by authority.

Our own experience with opium has long led us to distrust the use of lime, which the *Pharmacopœia* authorities have employed in both their editions. This use of lime is open to many objections, an obvious one being that as sal-ammoniac precipitates lime when added to such a solution as yielded by the *Pharmacopœia* process, and the precipitate is washed with distilled water, this water will dissolve the lime, which, in its turn, will dissolve the morphia, and thus be one cause of the large loss of morphia involved in the use of this process of the *British Pharmacopœia*.

Before we finally take leave of Mr. Allen and his useful book on the Alkaloids, he will doubtless allow us to state that we look upon morphia as being insoluble in benzene; that we find, experimentally, the evaporation of solutions of morphia at a moderate heat,—that of a water-bath,—involves no tendency to decompose the morphia; that we have no reason to think that any morphia remains dissolved in the morphia liquor, seeing that we wash with "morphiated spirits" and "morphiated water"; whilst we defeat any objection to colouring-matter or other impurity left with the morphia, by availing ourselves of his capital suggestion of titration of the morphia by an acid; see our Table on the effects of alcohol (Chemical News, vol. lvii., p. 94), where the morphia crystals, freed from the rest of the opium alkaloids and from narcotin, lose very nearly 1 per cent in weight by titration. This final

determination of the morphia by titration, which we owe to Mr. Allen, has not been used by any of the chemists whose processes we have investigated.

May we ask why Mr. Allen employs the term "assay of morphia," &c.? Do not let us Englishmen corrupt our own language. Surely "assay" to a chemist involves the idea of furnacing of some sort.

We have now cleared the way for considering our present process for the determination of morphia present in opium. We say designedly, our present process, which still rests on the proper use of the three reagents, morphiated spirit, morphiated water, and benzene, long employed by us, and described by the late Mr. Teschemacher, jun., in the Chemical News (vol. xxxv., p. 47). It must be a singularly perfect process of estimation, to our minds incompatible with vegetable substances, for chemists to have frequently and continuously employed a method for very many years without observing the advantage of improving and simplifying such methods, as we have done with the one in question. The conclusions we have arrived at, and stated in the foregoing pages, have suggested to us the improvements required, and the means whereby our process would be made to yield more trustworthy and more accurate results than were possible ten years since.

We now prefer to employ 200 grains of opium, if the sample permits,—

1. To thoroughly exhaust this with warm distilled water.
2. Then concentrate this watery extract to a thin syrup in a shallow dish, over a water-bath, which we prefer should not boil.
3. Transfer this thin syrup to a suitable flask, which permits the use of a soft cork, using a few drops of water successively, to wash out the dish. Add to the contents of the flask 50 fluid grains of alcohol, sp. gr. about 0·820, and about 600 fluid grains of ether. Mix gently, but thoroughly, and then add some 50 fluid grains of ammonia, sp. gr. 0·935.
4. Shake the contents of the flask well to precipitate the alkaloids in arenaceous crystals, with occasional agitation during the ensuing eighteen hours.
5. Transfer the contents of the flask to a vacuum filter, and permit all the adherent liquid to be drawn away, washing out the flask with our morphiated spirit, and continue its use till the liquid passes colourless. Now wash with morphiated water, till this also passes colourless.
6. Now dry, slowly at first, finishing at 212° F. Transfer the dried substance to a mortar, reduce it to a very fine powder, and digest it thoroughly in benzene, to dissolve the narcotin and such of the opium alkaloids, other than morphia, which may be present.
7. Transfer this mixture to a vacuum filter, wash out the mortar carefully with benzene, which use to wash the powder thoroughly. This, then, will be morphia, free from other opium alkaloids and narcotin, but still containing colouring and possibly other organic matters to the extent of 3 to 10 per cent. Dry and weigh this powder.
8. Now ascertain the percentage of crystallised morphia by titration of this powder with standard hydrochloric acid and litmus as the indicator, by weight. This acid is so made that 1000 grains by weight shall exactly neutralise 100 grains of pure morphia crystallised from water, washed with ether, and gently dried finally at 212° F.

We invite and shall welcome experimental criticisms on the foregoing method, but must be pardoned for neglecting to notice *obiter dictu* guesses, or opinions unsupported by experimental proof.

We do not claim perfection for our method, nor that it is impossible to extract more morphia from opium than we have hitherto done. We have taken many years to improve our method, so that we can procure considerably more morphia from opium samples than we formerly could do, and we quite hope yet to simplify or so improve our method that we may yet raise our results. We think that in any case such augmentation must be slight, seeing that the start and basis of our plan ensures the complete exhaustion of the opium under examination, and involves no taking of aliquot parts, but that as we begin with a known weight, so we end with the result from this known weight. It is true that certainly at two points of our method loss of morphia may occur, but the traditions and habits connected with a commercial laboratory of more than fifty years' standing, where analysis goes on from day to day, are great safeguards in this respect; whilst if the rumours which reach us are true it is not loss we are accused of, but its opposite. "Teschemacher and Smith are always too high" seems to be the complaint. The manufacturer of salts of morphia whose mode of manufacture yields him less, and always less, morphia than our returns, cries they are always "too high," instead of suspecting that his mode of manufacture demands rectification, and that he always loses morphia, and always must do so, unless he discovers and amends the sources of loss and leakage involved in his mode of working. This is human nature, as is also the belief we have met with at times that our returns of the valuable contents of any produce or drug manipulated by them should allow for the inevitable loss incurred in manufacture, at which we shook our heads as impracticable and outside the scope of our duties. One gentleman, as we have been informed, has distributed duplicate samples of opium among three or four chemists, with instructions to determine the amount of morphia in them, having already the results of our return of the same sample. All these analysts made returns lower, we think considerably lower, than we did; whilst, to confirm irrefragably our blundering, these gentlemen agreed very closely with each other. Could more be wanted? May we urge, in arrest of judgment, that these analysts may have adopted the process of the *British Pharmacopœia*, that of Mr. Stillwell, or some one of the many we have examined, when, in accordance with Squibb's law, the results will be almost exactly comparable among themselves.

It is, however, certain that none of the methods we have described yield so high a return of morphia as our own, and that loss is the characteristic feature met with in all these methods; whilst it is just as certain that our process cannot yield too much morphia,—*i.e.*, "too high" results.

All we pretend to do is to return results certifying to the amount of pure crystallised morphia which can be obtained from a given sample of opium. And, further, that we can and do obtain more morphia than has yet been procured from opium by other analysts.

Commercial Sale Rooms, Mincing Lane, and
1, Aubert Park, Highbury, London, February, 1888.

Notes.

For Morphiated Spirit.—Digest a large excess of morphia in rectified spirits of 80 per cent, for several days, with frequent agitation. Filter for use.

For Morphiated Water.—As above, substituting distilled water for spirit.

In the *Pharmaceutical Journal* (vol. xii., p. 704) we find it stated, on the authority of Dr. Squibb, that "For more than thirty years it has been unlawful for the United States Custom House examiners to allow any opium not containing at least 9 per cent of morphia to pass into the country." Thus the United States Custom House officials are able, at their will and pleasure, to pass or reject every case of opium imported.

In the foregoing pages we have shown that, granting the capacity to examine opium to these officials, involving a huge admission which we could not grant in good faith, yet these officials have no method whereby they could determine whether or no an opium does contain 9 per

cent of morphia; so that they cannot fulfil their instructions, but simply act according to their will and pleasure.

In illustration of the above, some friends of ours recently shipped ten cases of opium to New York, averaging 10·20 per cent morphia. Of these ten cases, six were rejected as containing less than 9 per cent morphia. We hear further that these rejected ones yield from 7·40 to 7·98 per cent: this second place of decimals, instead of 8 per cent, points to an accuracy which will, we fear, be for a long while the distinctive characteristic of the New York Customs' analysts.

If they be correct the happy consignee will secure four chests at 13½ per cent morphia instead of 10·20 per cent, —a gain of 3·30 per cent, solely due to the lawful action of the Customs of the United States.

ON THE RANGE OF MOLECULAR FORCES.*

By A. W. RÜCKER, M.A., F.R.S.

(Continued from p. 98).

Further experiments have been made by Ihmori (*Wied. Ann.*, xxxi., 1006, 1887). He finds that the water films on clean unvarnished metal surfaces are extremely thin, varying from 10 to 3 $\mu.\mu.$ On oxidising metal they may be twice as thick, and he inclines to the view that in all cases the phenomenon is due to oxidation. Varnished metal may in 20 m. absorb enough to produce a layer 286 $\mu.\mu.$ thick, and sealing-wax also absorbs large quantities. Nineteen experiments on quartz gave a mean thickness of 22 $\mu.\mu.$ with a maximum of 62 $\mu.\mu.$ Six observations made when the crystal had been previously washed gave a mean of 4 $\mu.\mu.$ and a maximum of 6 $\mu.\mu.$ only. The mean result of 11 experiments on platinum was under 3 $\mu.\mu.$ the maximum being 12·2 $\mu.\mu.$ In the case of a piece which was specially cleaned by heating, no condensation could be detected. Agate absorbs large quantities of water. Films, the thickness of which varied between 562 and 1640 $\mu.\mu.$, are stated to be the result of an hour's exposure to a moist atmosphere. It is, however, well known, though Herr Ihmori does not refer to the fact, that agate consists of alternate layers of quartz and a porous form of silica allied to opal. Professor Judd has kindly furnished me with specimens which have been immersed in coloured solutions. These have been absorbed by the porous layers, and thus coloured bands are formed. In this way a good imitation of an onyx may be produced. There can be no doubt that the surface exposed by the agate to the water-vapour includes that of the interior of a vast number of capillary tubes, and is enormously greater than the mere external surface. The quantity of water absorbed does not, therefore, give any indication of the thickness of the water-film, and no deduction as to the radius of molecular action can be drawn from it.

The net result of these experiments is to render it doubtful whether in the case of substances which are not dissolved or chemically acted on by water, any measurable temporary film is formed at temperatures above the dew point. If such a film is formed in these cases, its thickness is, according to Warburg and Ihmori, in general very much less than the radius of molecular action as determined by Quincke.

Pfeiffer (*Weid.*, viii., 635, 1884), who published some experiments on the absorption of gases by solids at high pressures, arrived at the conclusion that layers of ammonia and CO_2, of the thickness of 450 $\mu.\mu.$ and 240 $\mu.\mu.$, are formed on charcoal made from fir-wood. As, however, the result is based on calculations made from box-wood charcoal, in which it is assumed that it condenses SO_2, exactly in the same way as glass does, but little reliance can be placed on it. It is probable that water-films play as important a part in the apparent condensation of SO_2 on the surface of glass as they do in that of CO_2.

Another group of experiments has been made with iron oxide, alumina, and silica, which readily absorb water and CS_2. Thus Müller-Erzbach (*Exner's Rep.*, xxi., 409, 1885) measured the grains of finely-powdered oxide of iron under the microscope, and concluded that a certain area was greater than that of a given weight of the powder. He then deduced from this datum and the weight of CS_2 absorbed by the oxide the thickness of the film. Assuming that the specific gravity of the absorbed CS_2 was increased from 1·27 to 1·60, by causes similar to those which affect the specific gravity of water of crystallisation, he concluded that the film was at least 1000 $\mu.\mu.$ in thickness. Similar calculations (*Exner's Rep.*, xxi., 553, 1885) gave 1700 $\mu.\mu.$ for the thickness of a film of CS_2, adherent to alumina. He finally concludes that the radius of molecular action is at least 1500 $\mu.\mu.$ (*Wied. Ann.*, xxviii., 696, 1886). Kayser (*Wied. Ann.*, xiv., 450, 1881), as the result of experiments on the condensation of gases on glass thread, was of opinion that the quantity condensed depended on the closeness with which the fibres were packed, and that the radius of molecular action was of the same order of magnitude as the diameter of the threads. He fixes its magnitude at from 2000 to 3000 $\mu.\mu.$ As these observations were made before the importance of getting rid of the water film by heating had been demonstrated, they cannot be accepted as supporting this enormous value.

Passing next to the condensation of vapours to the more permanent gases, I may refer to a calculation made by Callendar,* on the assumption that the differences between the coefficients of expansion of air between 0° and 100° C., given by various air thermometers, depend on the quantity of air condensed, when they are cooled, and thus upon the ratio between the surface and volume of the bulbs, which of course varies with their shapes. He shows that the values for the coefficients of expansion of air at constant volume between 0° and 100° C. obtained by Regnault, Balfour Stewart, and himself, would agree if the weight of air condensed between those temperatures is 10^{-6} grms. per sq. c.m. From this we deduce that the thickness of the film removed by heating from 0° to 100° C. would be 10 $\mu\,\mu.$, if the density be assumed to be the same as that of water. Schumann (*Wied. Ann.*, xxvii., 91, 1886) has also recently pointed out that if the layer of air condensed on glass reaches such considerable dimensions, the length of a mercurial thread in a capillary tube would be appreciably different, according as the film was or was not present. He therefore connected a long bent capillary tube with a bulb, and when the positions of the ends of a thread of mercury had been determined it was transferred to the bulb. The tube was exhausted and heated to 312° C., which could be accomplished without heating the mercury. When the apparatus had become cold the mercury was returned to the capillary tube. Its length was found to be precisely the same as before. The thickness of the air film removed by the heating could not, therefore, according to Schumann, have been greater than 70 $\mu.\mu.$ His method of course involves the assumption, which seems legitimate, that the mercury would not remove the film from the glass as it moved along the tube.

An argument to the same effect may be drawn from some observations made by Bottomley (Chemical News, li., 85, 1885), and published in 1885. He exhausted a vessel containing glass fibres by means of a mercury pump until the pressure as indicated by a McLeod gauge was 0·3 M.† He then heated the vessel and its contents until some of the glass fibres began to soften, and collected the gas which was given off. It amounted in all to 0·45 c.c., at 15° C., and 760 m.m., and when analysed was found to contain 8·24 per cent CO_2, 24·8 per cent O_2, and 75·2 per cent N_2. The total surface of the fibres was 14·48 square c.m. The gas as it left the vessel was dried, and.

* A Lecture delivered before the Chemical Society, Feb. 2, 1888.

* "On the Practical Measurement of Temperature," *Phil. Trans.* clxxviii. (1887), A, p. 161).

† M = 1-millionth of an atmosphere.

it is not stated that the glass fibres had been previously washed, so that there probably was a water film of the magnitude of which no estimate could be formed. It is therefore probable that the gases were partly dissolved, but at all events the observations lent no support to the idea that the gas film on glass dried only by contact with dry air is very thick. If we assume that the mixture when collected was of the same density as air, and that when in contact with the glass it had the same density as water, the thickness of the film of condensed gas was 4 $\mu\mu$., which is somewhat less than the number deduced on the same hypothesis from Callendar's suggestion.

On the whole, looking only at the very contradictory results attained by different researches, and without regard to arguments which I shall presently adduce, I must confess that I do not think we can at present draw any certain conclusion as to the magnitude of the radius of molecular action from observations on the condensation of vapours or gases. To justify this view I cannot perhaps do better than quote from two of the gentlemen who have studied the phenomena most closely.

In 1885 Müller-Erzbach remarks (*Exner's Rep.*, xxi., 1885, 407):—"Ich habe nun . . . . in Mittel gefunden, durch welches ich auf einfache Weise glaube beweisen zu können, dass die in Betracht kommenden Molecularkräfte nicht nur bei unmittelbarer Berührung wirksam sind, sondern selbst noch in einem grösseren Abstand als ihn Hr. Quincke nach seinen Versuchen bestimmt hat."

In 1886 Warburg and Ihmori sum up these results as follows (*Wied. Ann.*, xxvii., 507, 1886):—"Es liegt uns fern, die Richtigkeit der Schlüsse Quincke's auzuzweifeln . . . . Allein in den Messungen, welche uri über das Gewicht der Wasserhaut bei Glas und anderen Körpern angestellt haben, ist uns nichts entgegengetreten, woraus eine Wirking der Molecularkräfte auf messbare Distanzen hin zu erschliessen wäre."

The first important attempt to measure the radius of molecular action was made by Plateau ("Statique des Liquides," 1873, i., 210). Arguing that the surface-tensions would decrease if the thickness of a soap film became less than twice the radius, he made experiments to determine whether the pressure exerted on the enclosed air depended on the thickness. His method was open to criticism. The soap-bubble was made of a mixture of soap, water, and glycerin, and thus its constitution would alter unless it were surrounded by aqueous vapour of a determinate tension. No precautions were taken to secure this condition. The bubble was produced at the end of a tube bent so as to form a manometer. The liquid used to measure the pressure was water, while the rate of thinning of the bubble was accelerated by enclosing it in a covered beaker in which were placed some sticks of caustic potash. Under these circumstances it is impossible to say what the final constitution of the liquid might be. By measuring the specific electrical resistance of various mixtures of glycerin and soap and water, and the resistance of cylindrical soap films formed of the same substances, Prof. Reinold and I have been able to measure the changes in the constitution of films when subjected to variations in the temperature or hygrometric state of the surrounding air. We found it very difficult to secure constant conditions, and that under circumstances far more favourable than those of Plateau's experiments the films lost one of the 57·7 volumes of water originally contained in every 100 of solution in times which varied between four and eight minutes (*Phil. Trans.*, Part II., 1881, 486).

(To be continued.)

The Dissociation of Hydrous Oxalic Acid. — H. Lescœur.—The use of oxalic anhydride in volumetry is not practicable. The author prefers to place crystalline oxalic acid under a bell over sulphuric acid at 53° B. At the common temperature it does not effloresce, but merely loses its supernumerary water.—*Bull. de la Soc. Chim. de Paris*, No. 2, 1887.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, March 1st, 1888.

Mr. William Crookes, F.R.S., President, in the Chair.

Messrs. Lewis Walter Hawkins and B. Henry Gerrans, Jun., were formally admitted Fellows of the Society.

The list of Office Bearers nominated by the Council to be balloted for on March 28th was read.

Certificates were read for the first time in favour of Messrs. Joseph Cowper, St. Andrew's Place, Penrith; Eugene MacSwiney, 18, Lower Kevin Street, Dublin; Henry John Palmer, 126, York Road, Bedminster, Bristol; John Cecil Watson, The Rhyddings, Oswaldtwistle, near Accrington; Thomas Howell Williams, 58, Lady Margaret Road, St. John's College Park, N.W.

The following papers were read:—

19. "*The Origin of Colour and the Constitution of Colouring Matters.*" By Henry E. Armstrong.

The majority of compounds, especially those of carbon, are colourless; and in the case of elements whose compounds are invariably coloured, the greatest diversity of colouring is often noticeable among the several compounds of one and the same element—as in that of chromium or manganese, for example: it is therefore clear that colour is in a high degree conditioned by special forms of intra-molecular structure, and consequently that any attempt to determine the "origin of colour" must be based on a knowledge of the structure of coloured matters. For this reason it has become possible only within recent years to discuss the relation between colour and constitution. The author first gives an account of what has already been done in this direction, and refers to Graebe and Liebermann's paper on "The connexion between constitution and colour in the case of organic compounds" (*Ber.*, 1868, 106); and to that of O. N. Witt—"Zur Kenntniss des Baues und der Bildung färbender Kohlenstoffverbindungen" (*Ibid.*, 1876, 522). Graebe and Liebermann laid down the rule as of universal application that, excluding coloured metallic salts of colourless organic acids, all coloured organic compounds which have been put to the test are decolourised by reducing agents (quinones, azobenzene, nitro-compounds, &c.); and from this they inferred that colouring matters either contain elements with incompletely saturated affinities, or certain of the atoms are present in more intimate association than their retention in the molecule necessitates. Notwithstanding the change in our views of the constitution of quinone, Graebe and Liebermann's conclusions appear still to be accepted, although if Fittig's contention that the quinones are diketones be correct, their conclusion that the colour of the quinones is conditioned by the intimate union of the oxygen-atoms obviously does not apply. Witt formulated the conclusion that the tinctorial nature of aromatic compounds is the consequence of the presence together of a colour-giving or *chromophoric* group, such as NO_2, CO, N : N, and of a salt-forming group—either OH or NH_2. This chemist directed his attention almost exclusively to the consideration of the nature of compounds possessed of tinctorial properties as distinct from mere coloured substances or pigments. The origin of colour, however, is presumably traceable to similar causes in both classes of compounds, while the property of acting as a dye may conceivably depend on peculiarities which stand in no relation to those which are causative of colour; this is an important question to determine.

The dominant idea on which the argument in the paper is based is illustrated by the author by comparison of the unsaturated hydrocarbons with the paraffins. In the paraffins, which are singularly inert compounds and all but colourless even in the infra-red and ultra-violet

regions of the spectrum, the carbon atoms are united only by single affinities, and the remaining affinities are engaged by *monad* atoms; the unsaturated hydrocarbons are not only more reactive than the paraffins, but the beginnings of colour are manifest in them if examination be made in the regions above and below the visible spectrum. The latter are conventionally represented by formulæ in which the carbon-atoms appear as united by two or three affinities of each, typified by straight lines or dots; these formulæ apparently serve to indicate that the value of a "double bond," is twice, and that of a "treble bond" thrice that of a "single bond," and there can be little doubt that this has long been tacitly assumed, although such a doctrine may not actually have been taught. But within recent years the idea has found favour that "affinity has direction"; v. Baeyer especially has availed himself of this hypothesis in his discussion of the differences in stability of various types of closed chain hydrocarbons. The author would apply it to polyad atoms generally; and in formulating compounds in which such atoms are united by more than single affinities, would represent the polyad atoms as united by curved lines in order to suggest that the affinities are under strain in consequence of their being free to act only in certain directions. In the paper, the author cites a large number of cases among inorganic compounds which he thinks afford evidence that the production of colour is dependent on special modes of atomic arrangement, and particularly on such modes of arrangement as involve the existence of a condition of strain in the resulting system, due probably to peculiarities in the affinity relationships of the constituent elements of the system which prevent complete mutual neutralisation of the affinities. The occurrence of colour, therefore, is more frequently than not concomitant with a high degree of reactivity, the coloured compound being usually one of "high potential" or slight stability.

Among carbon compounds there is no instance of a hydrocarbon being coloured, giving the term its conventional meaning; and omitting nitro-compounds, there are very few exceptions to the rule that derivatives of hydrocarbons containing only monad radicles are colourless; the exceptions, moreover, are of a very noteworthy character, being either *central* derivatives of anthracene, *i.e.*, compounds formed by displacement of the hydrogen atoms of the central nucleus of anthracene—which although not coloured is significantly fluorescent; or the monad radicle contains at its origin a radicle such as CO. A number of illustrations are given in illustration of this statement. Attention is then drawn to the quinones and their derivatives, Fittig's ketone formula being throughout adopted for these compounds. The author then discusses the constitution of the better known dye-stuffs, and is thereby led to conclusions which in some cases are different from those hitherto accepted.

Azo-Dyes.—Liebermann's experiments on benzene-azo-betanaphthol are referred to, and also those of Zincke and Bindewald, attention being specially directed to the production by these latter chemists from alphanaphthaquinone and phenylhydrazine of benzene-azo-alphanaphthol identical with that obtained from alphanaphthol and a diazobenzene salt. The author thinks that the general bearing of these results has escaped notice, and proposes to apply them to azo-dyes generally, formulating these as of the following types:—

$$O\supset C_6H_4\supset N\cdot NHR' \qquad HN\supset C_6H_4\supset N\cdot NHR',$$

according as they are derived from phenols or amines. The high tinctorial power of the azo-dyes would appear to meet with a more satisfactory explanation on this hypothesis than is afforded by Witt's theory, and it affords a simple explanation of the fact that no acid radicle other than OH, and only ortho- and para-hydroxy or amido-compounds are available for the preparation of azo-dyes. The cases in which this hypothesis will not apply are discussed in the paper.

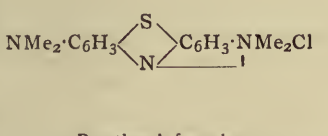
Rosaniline and its Congeners.—Although the formulæ usually assigned to these represent them as compounds of the quinonic type—assuming that in quinone the oxygen atoms although in the para-position are united to each other, the idea that they are quinonic compounds which Graebe, Liebermann, and Caro expressed prior to the publication of E. and O. Fischer's well-known investigation has apparently now been entirely lost sight of. The author would formulate them in the manner indicated by the following examples:—

$$O\supset C_6H_4\supset C(C_6H_4\cdot OH)_2 \qquad HN\supset C_6H_4\supset C(C_6H_4\cdot NH_2)_2$$

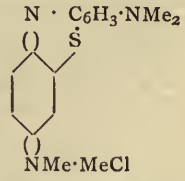
Pararosolic acid. Pararosaniline.

Phthaleïns.—v. Baeyer's researches are commonly held to prove that these compounds are derivatives of phthalide, $C_6H_4\left\{\begin{matrix}CH_2\\CO\end{matrix}\right\}O$. The arguments on which this conclusion is based are discussed in the paper; it is pointed out that the properties of the various compounds classed as phthaleïns are so diverse that it is desirable to more fully examine the evidence on which they are grouped together, especially as, apart from the assumption that the phthaleïns are phthalide-derivatives, there is little reason to believe that the lactides are chromophoric compounds. V. Baeyer supposes that phenolphthaleïn is formed from dihydroxytriphenylhydroxymethanecarboxylic acid by separation of the elements of water from the carboxyl and the methane hydroxyl, a lactonic anhydride being thereby produced; but if the hydroxyl of the carboxylic radicle were to separate with a hydrogen-atom of the neighbouring $C_6H_4\cdot OH$, a derivative of hydroxyphenylanthranol would be obtained. This latter constitution, however, has already been assigned to the phthalideïn isomeric with phenolphthaleïn. The conclusion that interaction does take place in this latter manner in the formation of fluoresceïns would serve to explain the fact that orcinol ($CH_3 : OH : OH = 1 : 3 : 5$) does not yield a fluoresceïn, whereas the isomeric cresorcinol ($CH_3 : OH : OH = 1 : 2 : 4$) does, as an anthracene-derivative could only be formed from an orcinol containing two *contiguous* undisplaced hydrogen-atoms. It is possible that certain of the phthaleïns are derivatives of phenylenediphenyl ketone, $C_6H_4(COC_6H_5)_2$. The formation of triphenylmethane-derivatives from compounds of this type can easily be accounted for, as benzil is converted by alkali into diphenylglycolic acid; and this assumption would serve to explain the formation of additive compounds with acids, such as are obtained from orcinphthalein, for example. It is noteworthy that the dimethanilidophthalein prepared from dimethylaniline is not only itself colourless, but yields colourless salts; this may be a true phthalide-derivative. Also that the diamidodiphenylphthalide which v. Baeyer prepared from diphenylphthalide and which he converted into phenolphthalein, when methylated yields a green compound apparently identical with the "phthalic-green" which O. Fischer prepared from dimethylaniline and which he represented as an anthracene-derivative.

Methylene-Blue.—It is suggested that this also is a quinonic compound, thus:—



Bernthsen's formula.



Quinonic formula.

Other dye-stuffs and coloured compounds are considered in the paper.

Discussion.

Dr. Debus said that Dr. Armstrong had called attention particularly to the type of coloured substances. Now flowers of sulphur at $-50°$ are white; larger pieces of sulphur are nearly colourless; but on warming both forms become more and more yellow, and at $+50°$ are of

an intensely yellow colour. Whatever be the type on which sulphur molecules are built up, there is not the slightest evidence that its chemical properties are changed between $-50°$ and $+50°$, or in other words that the structure of its molecules is altered. The colour of sulphur, therefore, is not dependent on its chemical type between $-50°$ and $+50°$, but on its temperature. Many similar examples can be quoted. Thus zinc oxide is white at common, and yellow at higher temperature. The influence of molar arrangement is seen in the following examples: larger pieces of silver are white, powder of silver is black; pieces of platinum grey, powder of platinum black; a sublimate of mercuric sublimate is dark brown, and powder of the same substance red. In all these cases there is no evidence that the molecular structure of the substances has undergone any change.

Professor Rücker said that if he had understood Professor Armstrong rightly his hypothesis was not in any way opposed to the idea that the forces between atoms acted in straight lines. If for purposes of illustration they made the crude supposition that a carbon-atom had four poles or centres of force on its surface, it was possible to conceive another atom adhering to one of the poles, or to a point on the surface half way between two of them. The heat of combination, the stability of the compound and so forth, would depend on the position assumed by the second atom relatively to the poles, but no single pole would have done the maximum amount of work which the attractions it exerted could perform on the atom until the latter finally adhered to it. In other positions there would therefore be a certain amount of "residual affinity." A position of more or less stable equilibrium might be found in which an atom combining with others was under the influence of a resultant force which was not equal to the sum of its individual components, and he believed that it was ideas of this kind which Professor Armstrong's notation was intended to convey.

As regards the question whether colour was due to the internal arrangement of the molecule, absorption was ordinarily attributed to vibrations set up among the atoms of which each molecule was composed.

He thought that attempts such as that embodied in the paper to connect the physical properties of substances with the molecular constitutions were necessary before any further attempt was made to frame a mechanical theory by which the connection should be explained.

Professor G. C. Foster referred to Professor Armstrong's remark, near the beginning of his paper, that, in the discussion of the colouration of bodies, their behaviour towards the invisible ultra-red and ultra-violet parts of the spectrum could not be separated from their behaviour towards the visible rays. In his opinion this remark was of fundamental importance. It appeared to him that the real question raised by Dr. Armstrong was whether a definite relation could be traced between chemical composition or chemical structure and the existence and position of absorption-bands in the spectrum of the transmitted radiation. The presence or absence of colouration, as it could be judged of directly by the eye, gave no conclusive answer to this question, for, as Professor Dewar had just reminded them, a substance might be as colourless as water, and still exert strong absorption in the ultra-red, or, as in some of the substances examined photographically by Professor Hartley, it might have strongly marked absorption in the ultra-violet. But, more than this, a body might exert selective absorption within the visible spectrum, but if it happened to absorb two complementary colours it would be judged of by the eye as though it were destitute of selective absorption altogether. The subject, therefore, seemed to him to involve a systematic study of absorption-spectra.

Dr. Morley saw great difficulty in applying to inorganic compounds Dr. Armstrong's hypothesis that the less stable bodies were the more highly coloured, and instanced the yellow and red mercuric iodides, the red iodide being the more stable at ordinary temperatures.

Mr. A. G. Green remarked that, as he understood, Dr. Armstrong considered the colour of organic colouring matters to be due to the unsaturated affinities or high potential of the quinone type to which these compounds can all be referred. Now he believed Dr. Armstrong regarded water as both an unsaturated and a coloured body, so, applying the same argument, why should not all aromatic compounds capable of being referred to the water type be coloured, or, at any rate, such as have sufficient molecular weight?

Dr. Armstrong, in reply, referring to Professor Foster's remarks, said that there was great difficulty in discussing colour, owing to the want of any agreement as to a colour scale, which made it impossible to compare effects produced in different regions of the spectrum; it would undoubtedly be necessary ultimately to take into account the absorption effected in the regions beyond the visible: at present, however, there was far too little information at our disposal for this purpose, but he believed that the same principles would apply in the main. In the course of the discussion he had been asked for explanations of matters which he did not pretend to explain; he did not claim that what he had said was particularly novel, but it did appear to him that it was of importance to group together the facts and the conclusions with regard to the character of coloured compounds in general at which he had arrived appeared to be of significance.

20. "*Researches on Chromorganic Acids. Part II. Certain Chromoxalates of the Red Series.*" By Emil A. Werner.

The author has further studied Croft's red salt, prepared by the interaction in aqueous solution of potassic dichromate and oxalic acid in the proportion of 1 to 7 molecules. Crofts gave to it the formula $K_2Cr_2(C_2O_4)_4 \cdot 12OH_2$, but the author finds only $10OH_2$. Six of the 10 molecules of water are readily expelled, the red salt becoming bluish-grey; but the remainder are removed with difficulty, complete dehydration being effected only at about 300°. The dehydrated compound is of a deep-green colour. It is proposed to represent the red salt by the formula—

$$Cr_2(OH)_2 \left\{ \begin{matrix} (CrO_2 \cdot OK)_2 \\ (CrO_2 \cdot OH)_2 \end{matrix} \right.$$

Several derivatives of the salt are described in the paper.

21. "*Note on Benzyldithiourethane.* By A. E. Dixon, M.D.

Several of the monalkyl substituted dithiourethanes are known. The following is a short account of a new member of the series. It was prepared early in 1887 in Professor A. W. Hofmann's laboratory.

Benzyl mustard-oil was sealed up in a tube with a quantity of ethyl mercaptan slightly in excess of that required by the equation—

$$CS : N \cdot CH_2 \cdot C_5H_5 + C_2H_5SH = CS(SC_2H_5)NH \cdot CH_2 \cdot C_6H_5.$$

The mixture was heated for five hours at a temperature of 120°, the tube opened, and the contents heated for a short time on the water-bath in order to drive off the excess of mercaptan. After standing for a few days the liquid solidified to a crystalline mass. this was dissolved in alcohol, and the alcohol allowed to spontaneously evaporate. By this means large transparent and perfectly colourless prismatic crystals were obtained, over 3 c.m. in length, nearly ¼ c.m. broad, the yield being over 80 per cent of the theoretical.

The substance is insoluble in water, moderately soluble in ether, benzene, and ligroïn, and extremely soluble in alcohol and bisulphide of carbon. The alcoholic solution is instantly desulphurised on warming with alkaline lead solution.

The crystals melt at 47° without decomposition; on heating more strongly the substance decomposes into mustard-oil and mercaptan. On analysis the following data were obtained:—

0·2545 grm. burnt with $PbCrO_4$ gave 0·5329 CO_2 and 0·1449 H_2O; or C=57·10 per cent, H=6·32 per cent.
0·2308 grm. fused with $Na_2CO_3 + KClO_3$ gave 0·5003 $BaSO_4$, or S=29·80 per cent.,

which agrees with the formula $C_{10}H_{13}NS_2$.

	Theory.		Experiment.		
C_{10} ..	119·7	56·82	57·10	—	—
H_{13} ..	13·00	6·17	6·32	by diff.	—
N ..	14·01	6·65	—	6·78	—
S_2 ..	63·96	30·36	—	—	29·80

PHYSICAL SOCIETY.

March 10th, 1888.

Professor Reinold, F.R.S., President, in the Chair.

Mr. C. E. Burton was elected a Member of the Society.

Mr. C. L. Addenbrooke exhibited and described a compact form of reflecting galvanometer, lamp, and scale, which he has designed as a portable commercial instrument, and also a modified Post-Office Wheatstone's Bridge. In the galvanometer the coils are easily removed or replaced by others, and loose wires for connecting the coils together are avoided, the required connections being made through the screws which secure the coils in position. The suspension is arranged so that the needle can be quickly taken out without breaking the fibre, and replaced by another for ballistic purposes if necessary. A simple liquid damping arrangement is provided. The lamp (a paraffin one) is enclosed in a copper cylinder, which also supports the scale. The height of the lamp and scale can be varied, and the beam of light can be directed at different altitudes by having the lens-tube mounted on pivots, the line joining them passing through the centre of the flame. The whole is very compact and portable.

Mr. E. C. Rimington read a paper "*On the Measurement of the Power supplied to the Primary Coil of a Transformer.*"

The first part of the paper contains a proof of a formula given by Prof. Ayrton, at a recent meeting of the Society of Telegraph Engineers, for measuring the power given to a transformer by using a Siemens' Watt-meter, and the disadvantages of the method are enumerated. A method is then described in which a high-resistance dynamometer is used. One coil of the dynamometer is placed as a shunt to the primary coil, and the other as a shunt to a known inductionless resistance, R, placed in series with the primary. The time constants of the dynamometer coils are made equal by adding an inductionless resistance to the one having the greatest time constant. Thus arranged, the difference of phase between the currents in the dynamometer coils is the same as that between the P.D. and current in the primary of the transformer. The mean power, p_m, is shown to be—

$$p_m = \frac{K}{R}\,\delta\,(1 + \tan.\phi_1), \text{ where } \frac{K}{R}$$

is the constant of the dynamometer for *Watts*, δ the reading of the torsion head, and ϕ_1 the lag angle of the currents in the coils of the dynamometer which can be determined from their time constant and periodic time. The best method of arranging the dynamometer, in order that R may be as small as possible, is discussed.

Prof. Ayrton pointed out that the formula first referred to by the author was given to show *why a Watt-meter should not be used*, and that the method suggested by Mr. Rimington was a modification of the well-known electrometer method, but with an additional serious objection, that the periodic time must be known. He also described a direct-reading method of using an electrometer, on ordinary transformer circuits, suggested to him by Mr. Sayers.

Mr. Blakesley thought the above formula given by Mr. Rimington would only be true where there is no iron in the circuit. He described a method of determining the power by observations on two low-resistance dynamometers, one of which is placed in the primary circuit. Of the other dynamometer, one coil is placed in the primary and the other in the secondary circuit. The power is given by—

$$p_m = A\,\alpha_1\,r_1 + r_2\,\frac{m}{n}\,C\,\alpha_3,$$

where r_1, r_2, m, n, are the resistances, and numbers of convolutions of the primary and secondary coils, A and C the constants of the dynamometers, and α_1, α_3 their readings. A geometrical construction from which the formula is deduced was given.

Mr. Sumpner said all the formulæ at present obtained were founded on the assumption that the induction coefficients of a transformer under working conditions are constant; but in a paper to be brought before the Society shortly, he hoped to show these assumptions to be erroneous.

In replying, Mr. Rimington said if the periodic time was not known beforehand, it could easily be determined from the note given out by a telephone placed near the transformer.

"*On the Magnetic Circuit in Dynamo Machines.*" By Prof. W. E. Ayrton and Prof. J. Perry.

An abstract was read by Prof. Perry. The authors have worked out a number of formulæ for dynamo machines involving the thickness, t, of the armature winding, and α, the highest permanent current density per sq. c.m. of section of that winding. One of these is—

$$W = \frac{2\,v\,N\,t\,\alpha}{10^8}$$

where W = highest permanent output in Watts.

v = circumferential velocity, and N = total induction through the armature. As the winding is thin $t\,\alpha^2 = q^2$, a constant. For the best modern machines, which do not get too hot, q has a value of about 288. It is shown that the best permanent output is a maximum when the magnetic resistance of the space occupied by the armature winding is equal to all the other magnetic resistance in the circuit, and the best machines are found to satisfy this condition. From this important result the characteristic of such a dynamo can be drawn with considerable accuracy. For small inductions the air resistance only need be considered, and a line drawn on squared paper connecting N and S′ A′, satisfying—

$$N = \frac{4\,\pi\,S'A'}{10} \div \frac{2\,(d+t)}{a_2},$$

gives the first part of the characteristic, where S′ A′ = ampère turns, d = clearance, and a_2 the area of the pole piece exposed to the armature (increased by a fringe of 0·8 $(d+t)$ all round). From the maximum value of N (viz. a_1, β_1), where a_1 = area of diametral section of iron in armature, and β_1 = maximum induction (17,000 to 18,000), find the value of S′ A′ from the formula—

$$N = \frac{4\,\pi\,S'A'}{10} \div \frac{4\,t}{a_2}$$

and plot the values of N and S′ A′ as the co-ordinates of a point. A curve drawn through this point to touch the line first drawn, at a point corresponding with $N = \frac{1}{2}\,a_1\,\beta_1$ will not differ materially from the characteristic of the constructed machine.

"*A Note on the Employment of an Electro-Dynamometer for Determining the Difference of Phase of two Harmonic Currents of Electricity*," by Mr. T. H. Blakesley, was taken as read.

This is a claim of priority for a method published by

the author in the *Electrician* of October 2nd, 1885, which has recently been described and claimed as the invention of Prof. Ferraris, in a paper communicated to the Royal Academy of Sciences at Turin. In a book on Alternating Currents, published at the end of 1885, Mr. Blakesley shows how the method can be used for determining induction coefficients and capacities.

CORRESPONDENCE.

INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—Will you allow me to state, in reply to certain letters which appeared in the Chemical News (vol. lvii., p. 79), that it was considered advisable by my coadjutors (in nominating certain gentlemen to replace an equal number of those nominated by the Council) to act like the Council itself in not previously asking their consent as to whether they would take office if elected.

In the pink circular issued by the Secretary marked "Important," it states that the (second) circular (bearing my name and giving a list of Fellows for whom those sympathising with our views were requested to vote) was not sent to all the members. This was not the case, the circular having been sent to *all* in the United Kingdom whose names appear in the last published list.

It is, perhaps, needless to say that the second circular bearing my name contains no such discourteous sentence as that given by Mr. Friswell in your last issue, viz., "that the Council is too much composed of mere Professors and Teachers of Chemistry."

From the pink circular above mentioned there seems to be a feeling that candidates nominated by the Council *should* be elected by the Fellows. I understood that the Council nominated certain gentlemen because the outside members, as a rule, did not trouble themselves about voting, but if they did exercise that right no member of the Council could feel aggrieved. Personally, I shall be very sorry if any action which we have taken should have hurt the feelings of any member of the Council, as we desired to show towards them the same good feeling and courtesy which they have always shown towards us.

The names of the gentlemen mentioned in circular "No. 2" were selected mainly because it was understood that they sympathised with the broader views which we advocated. The tendency of professors and lecturers, especially if they belonged to one of the twenty selected schools or colleges, would be not to sympathise with them.

If Mr. Friswell will look at the Council list he will find that 18 out of the 36 members are either professors or ex-professors, 5 are manufacturers, 6 hold Government appointments or are not actively engaged in general practice as consulting and analytical chemists, while 7 only belong to the last-mentioned class, and I think (in opposition to Mr. F.'s views) consulting chemists are as able and as willing to spend time in serving on the Council of the Institute as the lecturers or professors.

I hope Mr. Friswell will stand alone in crediting us with "jealousy."

Mr. Friswell refers to the fact that we might have nominated three candidates from outside, but did not do so. This arangement was not accepted by us because we did not consider that the election of only three more Fellows holding our views would give us the weight required for a fair discussion of the questions at issue.

Other references have been made to our movement as an attempt to gain personal or party ends to the detriment of the highest interests of the Institute, but I fail to see how a regulation passed by a body of the Council composed mainly of Professors or Lecturers to the effect that no one shall enter the Institute in future except through one of twenty schools or colleges in the United Kingdom (to which many of the Professors who assisted in passing this regulation belong) is less of a party or personal movement than one which simply says "that regulation is nonsense and will make the Institute into a clique, leaving out all the chemists educated on the Continent, and all those in the United Kingdom who have not obtained their chemical education in one of the specified schools or colleges.

I see nothing which is of the nature of a party or personal movement in our desire that the doors of the Institute should be thrown open to all comers provided they have attained sufficiently high standards as regards their general education and knowledge of mathematics, physics, and chemistry, and can show that they have worked through a regular course in any college, school, or laboratory of good repute.

It is true that "cramming" may be employed for the purpose of passing the examinations of the Institute, as is the case with all examinations, but the attendence at one of a specified number of colleges does not prevent the student from wasting his time during the sessions and then "cramming" at the end. The fact that upwards of two-fifths of all those who voted at the Annual Meeting were in favour of the changes we suggested in the Council is some guarantee that, if our movement is a party one, the party is a very large one, whose claims must be regarded as worthy of consideration.—I am, &c.,

William Thomson.

Royal Institution Laboratory,
Manchester, March 5, 1888.

INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—Surely it is unjust that the Fellows of the old Institute of Chemistry should have been charged an entrance fee of *five guineas* and *two guineas* subscription, while now and until the end of the present month new members are being freely enrolled at an entrance fee of *one guinea* and *one guinea* subscription. The injustice complained of is that members of the old Institute, believing in the official advertisements which appeared in this and other journals, to the effect that the time for the election of members would be limited, believing in this, they supported the Institute by their money and influence, and by these means obtained the Charter, while now that the Institute has become more valuable to its members the door of admission is freely opened at greatly reduced payments. I ask you, sir, is this fair to the members of the old Institute?—I am, &c.,

Justice.

March 5, 1888.

INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—I feel sure that most bona fide analytical chemists in active practice will extend their sympathy and support to the movement with which Mr. Wm. Thomson has so energetically identified himself with.

Since the foundation of the Institute letters of complaint appear, on reference, in nearly every volume of the Chemical News; and about two years ago the mode of admission into the Institute was freely discussed in these columns. It was then pointed out how absurd it was o the Council to adopt, or even contemplate the adoption, of the "examination before admission" plan.

But in spite of constant remonstrances from all quarters, the Council, in their wisdom, applied the examination system; and it is only too notorious what a conspicuous failure it has proven to be!

It is well known how many there are who enjoy the distinction of "F.I.C." who are not and never have been connected with analytical chemistry in their lives; and

on looking through the list of officers and members one cannot help wondering "how many of these have passed the peculiar examinations of themselves": not one in a hundred! Hence the absurdity of the Council attempting to dictate any examinations with its present lists of members before it.

The strongest advocates for the examinations appear to be those gentlemen connected with universities of recent foundation and "technical schools" (Heaven save the mark!), but who are not apparently graduates of any university!

These are the people who would try to compel men like myself, who have been in the profession over twenty years, to pay a tax and to be examined (!), forsooth, by them! Verily, they are professors!

Had the Institute been started on a sound healthy basis, I should have been only too glad to have supported it in voice and purse if necessary; but when I saw the manner in which "Fellows were made," and the way its business was transacted generally, I held and still hold aloof.

In conclusion, I would suggest to those dissatisfied with the Institute's proceeding; to those professional men who have no belief in examinations as now conducted, but in thorough practical training, and indeed to those of the profession who wish to elevate its "tone" *transparently* —the formation of a new Institute, founded on similar lines to the Institution of Civil Engineers; and it might be called the Institution of Analytical Chemists.—I am, &c.,

A. F. W.

Liverpool.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 8, February 20, 1888.

Preparation and Properties of a Potassium Fluoride, Bihydrofluoride, and Trihydrofluoride.—H. Debray.—Hydrofluoric acid combines readily with the neutral fluorides. Such compounds may contain one, two, or three mols. of hydrofluoric acid to the mol. of potassium fluoride. The two latter can be kept in a liquid state at 65° and at 100°, and they permit in certain cases the reaction of hydrofluoric acid either upon mineral or organic bodies.

New Reaction of the Products of Saponification of Cotton Oil permitting the Detection of One per cent of this Oil in Olive Oil.—Ernest Milliau.—The free fatty acids of cotton oil in an alcoholic solution (5 c.c. to 15 c.c. of alcohol at 90 per cent) are treated in the water-bath with 2 c.c. of a solution containing 30 grms. silver nitrate to 1 litre distilled water. After boiling for a few minutes the fatty acids reduce the silver nitrate and rise to the surface as a paste coloured black by the silver set at liberty. This reaction is not produced with the fatty acids of olive oil. The oil of sesame may be detected by agitating in a test-tube the fatty acids of the oil of sesame, well dried with an equal volume of sugared hydrochloric acid. The acid liquid at once takes a blood-red colour.

The Essence of Spike Lavender.—R. Voiry and G. Bouchardat.—This essential oil is almost entirely free from hydrocarbons, and contains an oxygenated compound identical with eucalyptol.

Bulletin de la Société Chimique de Paris. Vol. xlviii., No. 2, July 20, 1887.

The Hydrochlorates of the Chlorides. Ferric Chloride Hydrochloride.—R. Engel.—Already noticed.

A New Apparatus for the Accurate Determination of Urea in the Liquids of the Organism.—P. Cazeneuve and Hugounenq.—This paper does not admit of reproduction without the accompanying figure.

Two Crystalline Principles extracted from Red Santal Wood: Pterocarpine and Homopterocarpine.—P. Cazeneuve and Hugounenq.—Pterocarpine is a white body, finely crystalline, perfectly insoluble in water, insoluble in cold alcohol, more soluble in boiling alcohol, sparingly soluble in ether, soluble in chloroform, from which it deposits in splendid crystals. It is lævo-rotatory. At 145° it softens and melts at 152°, turning slightly yellow; if submitted to elementary analysis it gives $C_{10}H_8O_3$. It is a neutral body, insoluble both in acids and alkalies. Homopterocarpine has essentially the same properties and is composed of $C_{12}H_{12}O_3$.

Action of Ammonia upon Certain Chloro-derivatives of Ethane: Direct Fixation of the Elements of Ammonia upon Non-saturated Compounds.—R. Engel.—Previously noticed.

Transformation of Maleic Acid and Fumaric Acid into Aspartic Acid by the Direct Fixation of Ammonia.—R. Engel.—Already noticed.

Remark on the Constitution of Inosite.—R. Engel.—In showing that inosite may be regarded as a non-saturated hexavalent alcohol, M. Maquenne confirms the views advanced by the writer ten years ago.

Last Observation by M. Kupferschlæger to the Reply of M. Weill.—The conclusion of a controversy on a volumetric process for the volumetric determination of zinc in zinc powder.

The Substitution of Calcium Phosphate for Gypsum in the Clarification and Preservation of Wines.—M. Hugounenq.—The author shows that "plastered" wines do not improve by age, and that they often contain, in addition to potassium sulphate, salts of magnesium and aluminium. He proposes, as a substitute for gypsum, bibasic calcium phosphate or tribasic phosphates, if free from fluorides and iodides.

Speed of the Reaction of Plumbiferous Zinc with certain Acids in Various States of Concentration and Temperature.—W. Spring and E. van Aubel.—This paper does not admit of useful abstraction.

Certain Derivatives of Propane.—C. Winssinger.—The compounds in question are hydrated orthopropylic alcohol; mercaptan and the orthopropylic sulphides; orthopropyl-sulphonic acid; orthopropyle oxysulphide; the compound of calcium nitrate with propyl oxysulphide; diorthopropyl sulphone; and monopropyl-phosphoric acid and tripropyl-phosphoric acid.

A Novel Carbohydrate, "Quercine," found in Acorns.—MM. C. Vincent and Delachanal.—This compound approaches inosite in its properties, but is distinguished by its crystalline form, its much higher fusion-point, and its less ready solubility.

The Constitution of Clays.—H. Le Chatelier.—Already noticed.

The Molecular Specific Heats of Gaseous Bodies.—H. Le Chatelier.—The author gives his results in the form of a Table.

No. 3, August 5, 1887.

Identity of Dambose and Inosite.—M. Maquenne.—Already noticed.

On Colloidal Copper Sulphide.—W. Spring and G. de Boeck.—The authors suppose that insoluble bodies are polymers capable of existing in a simple soluble state. They prepare copper sulphide, soluble in pure water, by precipitating a solution of a copper salt with hydrogen sulphide and washing the precipitate by decantation in a solution of hydrogen sulphide in water. As the foreign matters are eliminated the copper sulphide becomes

soluble. The authors refer to the researches of Ebell, who has obtained ultramarine.

An Oxide of Manganese Soluble in Water.—W. Spring and G. de Boeck.—The authors obtain this substance by treating potassium permanganate with sodium thiosulphite and washing by decantation.

MISCELLANEOUS.

The Chemical Laboratory of Wiesbaden.—In addition to the director, Geh. Hofrath, Prof. Dr. R. Fresenius, there are engaged as teachers in the establishment Prof. Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Dr. E. Hintz, Dr. med. F. Hueppe, and Architect J. Brahm. The assistants in the laboratory in the Winter Term 1887—88 were 19 in number and in the Versuchsstation 3. Last term there were 75 students on the books. Of these, 45 were from Germany, 7 from North-America, 6 from Austro-Hungary, 5 from England, 5 from Sweden, 5 from Russia, 1 from France, 1 from Belgium, and 1 from Italy. During the last term, besides the scientific researches, a great number of analyses were undertaken in the different departments of the Laboratory and the Versuchsstation on behalf of manufacture, trade, mining, agriculture, and hygiene.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Bleaching Soft Soap.—A beautiful white soft soap has been in the market for many years. It is, or was, used in the silk trade. Try Price's (or other) soap makers.—G. A. Keyworth.

MEETINGS FOR THE WEEK.

ONDAY, 19th.—Medical, 8.30.
— Society of Arts, 8. "Alloys," by Prof. W. Chandler Roberts-Austen, F.R.S.
— Society of Chemical Industry, 8. "The Polariscope and its Application to Brewing," by John Heron, F.I.C., F.C.S.
TUESDAY, 20th.—Institution of Civil Engineers, 8.
— Pathological, 8.30.
— Society of Arts, 8. "What Style of Architecture should we follow?" by William Simpson.
— Royal Institution, 3. "Before and After Darwin," by George John Romanes, F.R.S.
WEDNESDAY, 21st.—Meteorological, 7.
— Society of Arts, 8. "The Evils of Canal Irrigation in India and their Prevention," by T. H. Thornton, C.S.I., D.C.L.
THURSDAY, 22nd.—Royal, 4.30.
— Royal Society Club, 6.30.
— Telegraphic Engineers, 8.
— Royal Institution, 3. "Microscopical Work with Recent Lenses on the Least and Simplest Forms of Life," by The Rev. W. H. Dallinger, LL.D., F.R.S.
— Parkes Museum, 5. "Physical Training of the Greeks and Romans," by A. S. Murray.
FRIDAY, 23rd.—Quekett Club, 8.
— Royal Institution, 9. "A Lecture with—and without—point," by Sir Frederick Bramwell, D.C.L., F.R.S.
SATURDAY, 17th.—Royal Institution, 3. "The Modern Drama: English," by William Archer.

For Sale.—MURIATE OF POTASH and FISH SALT, about Fifty Tons of each.—Apply, A. BEST, Chemical Works, Guernsey.

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By JAMES JOHNSON, Barrister-at-Law, and J. HENRY JOHNSON, Assoc. Inst. C.E., Solicitor and Patent Agent, Authors of "The Patentee's Manual."
London: LONGMANS, GREEN, and CO., Paternoster Row.

CHEMICAL LABORATORY,
WIESBADEN, GERMANY.
Director—Prof. R. FRESENIUS, Ph.D.

Practical Instruction in the Laboratory .. .. Prof. R. FRESENIUS, Ph.D. / Prof. H. FRESENIUS, Ph.D. / W. FRESENIUS, Ph.D. / E. HINTZ, Ph.D.

LECTURES.

Experimental Chemistry (Inorganic) — Prof. H. FRESENIUS, Ph.D.
Experimental Physics .. .. / Stöchiometry .. .. — W. FRESENIUS, Ph.D.
Organic Chemistry.. .. .. — E. HINTZ, Ph.D.
Chemical Technology .. .. / Microscopy, with exercises in Microscopic work .. .. — E. BORGMANN, Ph.D.
Chemistry and Analysis of Foods .. — Prof. H. FRESENIUS, Ph.D. / E. BORGMANN, Ph.D. / W. FRESENIUS, Ph.D., and / E. HINTZ, Ph.D.
Hygiene .. .. / Practical exercises in Bacteriology.. — Dr. med. F. HUEPPE.
Technical Drawing, with exercises .. — J. BRAHM.

The next Session commences on the 24th of April. The Regulations of the Laboratory and the Syllabus of Lectures will be forwarded gratis on application to C. W. Kreidel's Verlag, at Wiesbaden, or to the undersigned.

Prof. R. FRESENIUS, Ph.D.

ST. PAUL'S SCHOOL.—An Examination for filling up about Four Vacancies on the Foundation will be held on the 11th of April, 1888, and following days.—For information apply to Mr. S. Bewsher, Bursar, St. Paul's School, West Kensington.

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THE CHEMICAL NEWS.

Vol. LVII. No. 1478.

ACTION OF SULPHUR CHLORIDE ON OILS.

By THOMAS T. P. BRUCE WARREN.

The following details of the *modus operandi* which I generally adopt for examining oils and mixtures of oils and fats may be useful to others interested in this subject.

The sulphur chloride should be mixed with an equal volume of carbon disulphide and kept ready for use. Unless otherwise stated the yellow chloride is referred to; it should be free from *dissolved* sulphur.

Five grms. of the oil or mixture are weighed in a tared porcelain dish, which is well glazed both inside and out; it should have a capacity of about four ounces, so as to avoid loss from spitting. It should not be covered. 2 c.c. carbon disulphide is stirred in and 2 c.c. of the mixture of sulphur chloride added. It is now placed on a hot water-bath and well stirred until the action has fairly commenced; when solidified it is placed in a warm chamber, so as to drive off all volatile products. When two successive weighings are the same it is ready for further operation. The mass will require breaking up so as to allow imprisoned vapours to escape.

The colour and consistency at the end of the reaction and when subsequently dried should be noted; it is now ground up or divided as much as possible. The product may be too tough to break up easily, or, if soft and sticky, a portion of the unaltered oil should be removed first.

It is transferred to a filter tube and well washed with carbon disulphide, so as to remove all traces of unaltered oil, &c., which is received in a tared flask; about 200 c.c. will suffice in any case. It is best to break up the mass after partial exhaustion, especially when the product is hard and tough or soft and adhesive.

Oils, fats, resins, rosin oils, petroleum, &c., not acted on by sulphur chloride so as to yield solid products, may be separated. The melting-point of a fat before and after separation of the oil is an interesting and useful matter. The viscosity of a mixture containing an ingredient acted on by sulphur chloride is of importance in examining lubricating compounds. Let us, however, remember that some resins yield insoluble compounds with sulphur chloride.

It is advisable to perform the experiments in duplicate so as to obtain a check on the result, the difference should not exceed what we allow on an ordinary commercial analysis.

The washing with disulphide is carried on under pressure; a foot blower is convenient, but by closing the top of the filter tube and clasping it with the warm hand will be sufficient. The exhaust will, in some cases, give a further yield of solid product; in these cases, if a larger quantity of chloride be used in the first place, a harder product will be obtained. This is not to be recommended unless for special purposes, because uniformity is aimed at in result, and it is not desirable to alter the oils too much.

The exhaust is weighed after removal of disulphide, and when the weighings are constant, this is deducted from the contents of the dish, by which we obtain the weight of insoluble solid product. This procedure is more simple and reliable than weighing the insoluble solid product. The smell and colour of the exhaust will, in many cases, reveal what the oil itself is, in spite of blending, refining, &c.

The colour and tenacity of the solid product is so very characteristic in most cases that no difficulty will be felt in deciding what the oil or mixture is; thus, arachis oil in lard or olive oil can be instantly detected from cotton-seed oil. Arachis oil is largely adulterated with cotton oil, and I have no doubt that in many cases where cotton oil is supposed to be present as an adulterant, the intention of a manufacturer has been to use arachis oil. I propose to examine this double adulteration shortly.

Sulphur chloride is sometimes decomposed when added to an oil; the deposited sulphur is removed from the exhaust by washing with ether saturated with sulphur. The oily portion is taken up, leaving the sulphur; we then obtain the weight of exhaust minus the sulphur. If much sulphur is present the exhaust has a cloudy white appearance. This indicates, generally, that the chloride is in excess.

I give the experimental data obtained on a mixture of poppy and linseed oils, both of which are similarly but unequally affected by the same quantity of this reagent.

	Grms.	Grms.	Mean.
Mixture, composition unknown, supplied for Fine Art painting :—			
Weight solid product	6·49	6·47	6·48
,, exhaust	1·11	1·12	1·12
,, insoluble residuum ..	5·38	5·35	5·36
Poppy oil gives :—			
Weight solid product	6·43	6·48	6·46
,, exhaust	1·98	1·93	1·96
,, insoluble residuum ..	4·45	4·55	4·50
Linseed oil gives :—			
Weight solid product	6·33	6·39	6·36
,, exhaust	0·75	0·81	0·78
,, insoluble residuum ..	5·58	5·58	5·58

First approximation. Linseed oil, 2·74 grms. Poppy oil, 2·25 grms.

Weight solid product	6·44 grms.
,, exhaust	0·92 ,,
,, insoluble residuum ..	5·52 ,,

We obtain by this approximate mixture too much insoluble residuum and too little exhaust, showing that linseed oil was in excess, and that poppy oil was insufficient. The colour and tenacity of the product showed that this was a very near approach to the mixture.

Second approximation. Linseed oil and poppy oil, 2·5 grms. each.

Weight solid product	6·47 grms.
,, exhaust	1·10 ,,
,, insoluble residuum ..	5·37 ,,

I may just point out here what the average results may have led us to anticipate :—

	Insoluble product.	Exhaust.
Poppy oil.. ..	4·50 grms.	1·96 grms.
Linseed ,, ...	5·58 ,,	0·78 ,,
Mean	5·04 ,,	1·37 ,,

so that although we may expect the total solid products to be near what we want, the weight of exhaust is at variance with our requirements, and hence the insoluble product. The linseed oil and poppy oil were obtained from the same firm who supplied the mixture.

The only explanation which I am able to offer is, that by mixing an oil which yields a large amount of exhaust with another oil which yields much less, we are modifying the solvent action of the unaltered portion of the former. A mixture of arachis and cotton oil confirms this. It is on this *mutual action* that the separation of cotton oil in margarine is brought about. We diminish the solvent action of the fats present by increasing the quantity of oil which is affected by sulphur chloride.

NOTE ON THE

OCCURRENCE OF EPSOMITE ON WHITE ISLAND, NEW ZEALAND.

By R. W. EMERSON MACIVOR, F.I.C., F.C.S., F.R.G.S., &c.

I HAVE already dealt with some of the more remarkable mineralogical features of the well-known active volcano in the Bay of Plenty, New Zealand (CHEMICAL NEWS, vol. lvi., pp. 251 to 253), and would now supplement my observations with a note on the occurrence of epsomite.

This mineral is met with in many places on the gypsum covered floor of the crater in the form of an efflorescence having the familiar saline bitter taste.

After careful drying between the folds of white blotting-paper it has the composition $MgSO_4.7H_2O$, and contains a distinct trace of ferrous sulphate.

ON THE RANGE OF MOLECULAR FORCES.*

By A. W. RÜCKER, M.A., F.R.S.

(Continued from p. 106).

As Plateau's film lasted two days, it is evident a change of composition sufficient to have caused a marked or considerable change in surface-tension due to thinning might have occurred. Plateau observed no change in the pressure when the colours of the bubble proved that its thickness was 11·8 $\mu.\mu.$ and thence concluded that the radius of molecular action is $< 59\ \mu.\mu.$ This inference is not so certain as he appears to have thought it to be. Maxwell (Art. "Capillary Action," *Enc. Brit.*, ed. ix.) has shown that if we neglect the change of density in the surface of the liquid and the thermal phenomena which accompany the thinning of a film, the surface-tension will remain unchanged until the thickness is equal to the radius of molecular action. It is difficult to estimate the extent to which this result might be affected by a theory which took cognisance of the motion of molecules and the change of surface-density. Perhaps, therefore, all that we are entitled to say is that if no change is observed in the tension of a film of given thickness, the radius of molecular action must be less than that thickness, but that if a change is observed it must be greater than half that thickness. Thus the superior limit fixed by Plateau's experiment would be twice as great as has been generally assumed to be.

Quincke (*Pogg. Ann.*, 1869, cxxxvii., 402) attacked the problem in another way. He placed a layer of Martin's silvering solution between a glass cylinder of 120 m.m. radius and a plane sheet of glass. A double wedge of silver, which was thinnest in the centre, was deposited on the surface. Two sheets of glass thus prepared were fastened together with a small interval between them, with their silver sides inwards, and adjusted so that silver layers of equal thickness were as nearly as possible opposite to each other. A glass cell, open at the top and bottom, having thus been formed, the lower part was immersed in distilled water. The cell being vertical the water rose highest in the centre, where it might be considered to be in contact with the glass. On each side, as the silver sheet became thicker the capillary elevation diminished. It was measured at known distances from the centre, and the angle between the solid and the liquid surface calculated. This would become constant when the thickness of the silver layer was such that the attraction of the glass on the water was negligible. The silver was afterwards converted into iodide of silver, and the thickness of the layer at different parts deduced from the colour. Similar experiments were made with other substances. The results may be summed up as follows, if we write ρ for the radius of molecular action in terms of micro-millimetres :—

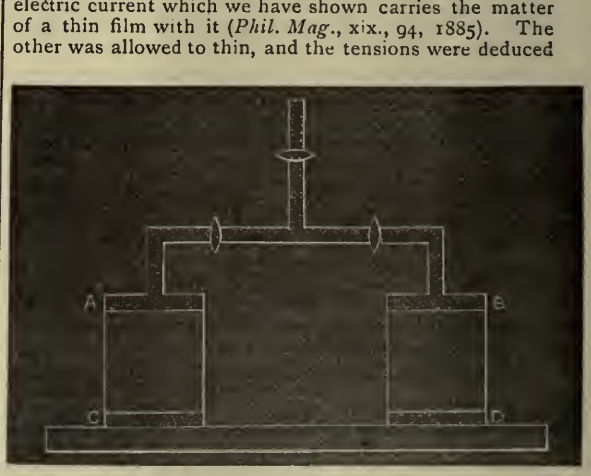
$\rho > 54{\cdot}2$ for water, silver, and glass,
$= 43{\cdot}3$,, mercury, sulphide of silver, and glass,
$= 59{\cdot}0$,, mercury, iodide of silver, and glass,
$< 80{\cdot}0$,, mercury, collodion, and glass.

The quantity of ρ as given by these experiments strictly speaking measures, not the radius of molecular action, but the distance at which the difference between the molecular forces exerted by glass and silver becomes inappreciable. This would probably be somewhat less than the true radius, but, nevertheless, the net result is to show that the radius of molecular action is approximately $= 50\ \mu.\mu.$ It is much to be desired that this conclusion should be in every way tested, and that similar observations should be undertaken by other physicists. I hope to show in the course of this lecture that it does receive important confirmation from the behaviour of thinning soap films.

Plateau's experiment has been repeated and modified in various ways. Lüdtge (*Pogg. Ann.*, cxxxix., 1870, 620), instead of directly measuring the pressure exerted by bubbles, compared the pressures due to thick and thin films by balancing them against each other. A soap film having been formed at the end of a tube, it was allowed to thin, and the other end was then closed by another film. Air was forced in, the films assumed the form of spherical segments, and their curvatures were compared. If p is the pressure exerted by a soap bubble of which T and R are the surface-tension and radius respectively, $p = 4T/R$. Hence if the tensions of the thick and thin films were different, their radii would be different also. He concluded that the radius of molecular action was much larger than Plateau and Quincke's observations would have led us to suppose, and that, contrary to expectation, the thicker film had the less surface-tension. His experiments were repeated and extended by Van der Mensbrugghe (*Bruxelles Acad. Sci. Bull.*, xxx., 1870, 322), who was unable to detect the alleged change of tension. Afterwards, however, he suggested and adduced experiments to prove that the phenomenon was probably real, and due to the cold produced by the continual evolution of fresh liquid surfaces as the films thinned (*Bruxelles Acad. Sci. Mem.*, xliii., 1882, No. 4, 18).

Lastly, Professor Reinold and I (*Phil. Trans.*, clxxvii., Part II., 627, 1886) have employed similar methods.

We balanced two cylindrical films, the one against the other; one of them was kept thick by passing up it an electric current which we have shown carries the matter of a thin film with it (*Phil. Mag.*, xix., 94, 1885). The other was allowed to thin, and the tensions were deduced



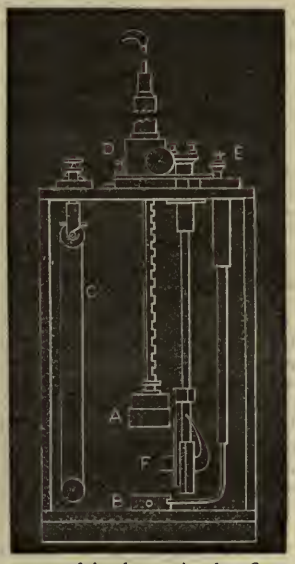
from the curvatures. The above figure represents diagrammatically the essential parts of the apparatus. The cylinders were formed between platinum rings, and their

* A Lecture delivered before the Chemical Society, Feb. 2, 1888

interiors could be put in connection with each other or with the external air by stopcocks. The apparatus actually used was somewhat complicated. The films were formed in a closed glass box surrounded by water. They could be made and adjusted without opening the box, so that the temperature and hygrometric state of the enclosed space were constant. A difference of surface-tension was indicated by a bulging of one film and a contraction of the other. Several possible causes of error were investigated, and as the distorted films were unduloids, formulæ were devised by means of which we could at once calculate the difference of the tensions of the two films when their lengths and maximum or minimum diameters were known. We found, as has indeed been noticed by others, that the surface-tension of a newly-formed film diminishes, and that from 10 to 15 minutes must elapse before it acquires an approximately constant value. By measuring the magnitude of the changes of surface-tension thus developed we proved that they were far too great to be accounted for, as Van der Mensbrugghe supposed, by cooling due to thinning. The calculated change was 0·0016 per cent, while we observed changes of 9 per cent. The effect is probably only a striking instance of the difficulty of preserving a liquid surface pure.

If, however, two films of very different thicknesses, but neither of which had been very recently formed were compared, the difference of tension (if any) was very small, and was not constant either as to sign or amount. We concluded that no evidence of a change in surface-tension dependent on the thickness of the film is furnished by a direct comparison of the tensions of thin and thick films over a range of thickness extending from 1350 millionths of a millimetre down to the stage of extreme tenuity when the film shows the black of the first order of Newton's scale of colours. Had any such difference as large as one-half per cent of the value of the tension existed we must have detected it.

The magnitude of the lower limit when the film appears black was given by the results of a previous research (*Phil. Trans.*, Part II., 1883, 645). We had determined the thickness of black soap films by measurements based on two independent methods, the one electrical, the other optical. In the first we measured the resistance of cylindrical films and deducted the thickness on the assumption that the specific resistance was the same as that of a thick layer of the same liquid.



The apparatus used is shown in the figure. The film was formed between the platinum rings A and B. The lower part of the glass vessel was flooded with the solution, and C is an endless linen band which dipped in the liquid, and could be rotated from the outside. It was thus kept moist, and the hygrometric state of the air was maintained at a constant point. The current flowed from the binding screw D to A, thence through the film to B and E. At F a pair of insulated gold wires penetrated the film. They were connected with the opposite quadrants of an electrometer, and the differences of potential between them and between the extremities of a known resistance inserted in the circuit were measured alternately. From these the resistance of the film between the needles was deduced.

In the second method we passed the two rays of light used in an apparatus* for the production of the phenomenon of interference by means of thick plates through two tubes in which a number of plane films have been formed. A known number of films was then broken in each tube in turn. The thickness was deduced from the displacement of the interference bands on the assumption that the mean refractive index of the thin films was the same as that obtained by the ordinary methods from experiments on the liquid in mass. The results may be summarised as follows:—

Liquid.	Method.	No. of films observed.	Mean thickness in terms of 10^{-6} m.m.	Probable error of a single observation.
Liquide glycérique	Electrical	5	11·9	±0·2
,, ,,	Optical	7	10·7	±0·6
Soap solution, without glycerin	Electrical	13	11·7	±1·4
	Optical	9	12·1	±0·8

The close agreement between these numbers, obtained by different methods, and by calculations based upon differs ent assumptions, proves conclusively that the thicknes- of a black film is generally about 12 $\mu.\mu$. We found that the thickness of different films might vary within several millionths of a millimetre, but that in any given film the thickness of the black part remains constant—at all events from a short time after its first formation. At first sight, then, it appears as though our result was in direct opposition to that obtained by Quincke, and proved that the radius of molecular action is $< 12\ \mu.\mu$. This is not the interpretation we ourselves put upon it. The black and coloured parts of a film are separated by a sharp line, which shows that there is a discontinuity in the thickness. Thus in extreme cases the rest of the film may be 250 times thicker than the black part with which it is apparently in contact.

(To be continued).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, March 15th, 1888.

Mr. William Crookes, F.R.S., President, in the Chair.

Messrs. Charles Francis Townsend, John Frederick Hayes, and D. A. Nagel were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Ludwig Claïsen, 6, Sopheinstrasse, München; William Henry Dodd, 8, Kempson Road, Fulham, S.W.; John Gill, Gwealhellis, Helston, Cornwall; Frederick Preston de Jong, South Shore, Blackpool; Thomas Enraght Lindsay, B.A., Royal Medical College, Epsom; John George Taylor, 12, Ernest Street, Jarrow-on-Tyne; James Woodward, The Laboratory, Somerset House, W.C.

The following were duly elected Fellows of the Society:—Messrs. Alfred Chiddy, Thomas Ashcroft Elwood, Harold Nicolai Faber, James H. Gardner, James

* Sometimes called a Jamin's interferential refractometer.

Hart, C. Millard King, Vivian Byam Lewes, Charles E. Munro, Frederick G. Ruddock, H. Belcher Thornton, Thomas Edward Towerson, Herbert Trewby, Edward Arthur Wates.

The following papers were read :—

22. "*The Nature of Solutions as elucidated by the Heat evolved on their dilution. Part I. Calcium Chloride.*" By S. U. Pickering.

The data afforded by the experiments of Berthelot and Thomsen being insufficient to determine the nature of the action which takes place on diluting aqueous solutions, the author has undertaken an elaborate examination of the question, selecting calcium chloride and nitrite as the subjects of study.

A new form of mixing calorimeter has been devised, consisting of an oval platinum beaker, divided into two compartments by means of folding doors; this apparatus secures the identity of the temperatures of the two liquids before mixing, and obviates a dependence on the accurate comparison of two thermometers. The heat capacity of the solutions was determined by means of two equal resistence coils through which the same current flowed and which heated simultaneously a known weight of water and of the solution under examination.

Experiments with the weaker solutions were conducted in the mixing calorimeter; the stronger solutions were treated like solids, the heat of their dissolution in a large quantity of water being determined. The strongest solutions dealt with were supersaturated, containing only 5·7 H_2O; the weakest one contained 1400 H_2O, or 0·4 per cent $CaCl_2$.

Various methods of graphic representation were examined, but the only one which led to satisfactory results was the plotting of the heat of dissolution (in an infinite amount of water) of 100 grms. of solutions of various strengths against the percentage composition of these solutions.

The results form a curve of great regularity, but this regularity is only apparent; on differentiation a series of independent curves are obtained, each of which on further differentiation gives a straight line. (The lines are straight within experimental error, but they all exhibit an inclination towards a curved form, which suggests the possibility of the action being even more complicated than is here shown.) Neither these straight lines nor the first differential curves meet at the points of change when produced. A second differentiation being necessary to reduce the original curve to straight lines, it follows that the action is represented by the equation :—Heat of dissolution $= A + \alpha p + \beta p^2 + \gamma p^3$, p being the percentage composition, and the other letters constants.

Owing to the multiplicity of the breaks and the smallness in the percentage difference corresponding to each additional H_2O, the case is one of extreme difficulty, and the exact position of the breaks is in some instances a matter of uncertainty. To obtain confirmatory evidence the densities of the various solutions were examined; the curve by which they are expressed split up on differentiation into a series of straight lines, as in the cases examined by Mendeleeff, and the points at which the breaks occur in the curve correspond in every case with those occurring in the heat curve, and, moreover, corresponded as accurately as can be expected with definite molecular proportions of water. The breaks are as follows :—

In heat curve. P.c. $CaCl_2$.	In density curve. P.c. $CaCl_2$.	Mean. P.c.	Composition.	P.c. $CaCl_2$.
50·84	—	50·84	$CaCl_2,6H_2O$	=50·66
45·73	46·62	46·18	$CaCl_2,7H_2O$	=46·81
43·46	43·10	43·28	$CaCl_2,8H_2O$	=43·51
38·52	38·52	38·52	$CaCl_2,10H_2O$	=38·12
32·70	31·8	32·25	$CaCl_2,13H_2O$	=32·15
26 35	25·85	26·10	$CaCl_2,18H_2O$	=25·50
17·52	18·75	18·13	$CaCl_2,28H_2O$	=18·04
6·51	7·40	6·95	$CaCl_2,90H_2O$	= 6·41
0·42	0·49	0·45	$CaCl_2,1400H_2O$	= 0·44

It having been already shown before this Society that the variation in electrical conductivity and the density of sulphuric acid on diluting with water unanimously prove the existence of certain hydrates in solution, as the results of the study of the densities and the thermal changes are shown to be equally unanimous in the case of calcium chloride solutions, the author is of opinion that there can therefore no longer be any reasonable doubt but that solutions do in reality consist of such hydrates, and holds that any theory of the nature of solutions which ignores their existence must be rejected absolutely and for ever.

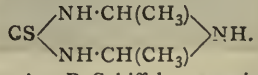
Discussion.

Dr. Armstrong said that although personally he was prepared to agree with Mr. Pickering in his conclusions, he thought that probably very many chemists would hesitate to accept Mendeleeff's explanation until evidence of the existence of definite hydrates in solution had been obtained by discussing the dependence of a greater variety of properties on composition: the fact that the same results were arrived at by discussing heats of dissolution and densities in the case of calcium chloride was therefore a most valuable addition to our knowledge. Mr. Pickering had incidentally raised the question whether the curves actually met at points corresponding to definite hydrates —the observations hitherto made were not sufficiently numerous to determine this, but judging from the results arrived at by Mr. Crompton in discussing electrical conductivity values, they probably did not; it was necessary, in fact, to prolong the curves in order to determine the points of intersection. The curves begin to change direction at some distance on either side of the points corresponding to particular hydrates: this probably was due to the fact that in a given solution, even before sufficient or more water is present to form a hydrate, A, a varying quantity of a hydrate, B, richer in water, or of a hydrate, C, containing less water, according to circumstances, is formed. If this be the case, it is to be expected that if sufficiently numerous observations are made at different temperatures, it will be possible by Mendeleeff's method to determine not only the nature of the hydrates present, but also within certain limits the extent to which dissociation has set in.

Mr. Crompton pointed out that Professor Pickering's results again showed the necessity, in this and kindred problems, of no longer assuming a curve to be continuous simply on account of its presenting a smooth and regular appearance: on analytical treatment such an apparently continuous curve might break up and prove to be discontinuous and made up of a series of curves, as in the present case. The apparent regularity of Thomsen's heat of dissolution curves was largely owing to the method of representation adopted, and want of a sufficient number of observations in most cases prevented an analysis of his results. The method hitherto pursued of merely measuring the heat evolved at points where breaks in the curve might be expected to occur, was also hardly calculated to lead to the detection of such breaks, as these would best be discovered when the directions of the intermediate curves had been determined.

23. "*The Action of Triocyanates on Aldehyde Ammonias.*" By A. E. Dixon, M.D.

The author describes the products of the interaction of benzylthiocarbimide with aldehyde-ammonia and valeraldehyde-ammonia; of ethyl-, allyl-, phenyl-, and orthotolylthiocarbimide with aldehyde-ammonia; and of phenylthiocarbimide with valeraldehyde-ammonia. They apparently may all be regarded as derivatives of the compound which Nencki obtained from thiocarbamide and aldehyde-ammonia; this the author represents as a closed chain compound of the formula—



It is pointed out that R. Schiff, by operating in practically the same way, obtained compounds differing in composi-

tion from those obtained by the author; and it is suggested that Schiff may not have prepared the substances in a sufficiently pure state for analysis.

24. "*Carboxy-derivatives of Quinone.*" By J. U. Nef.

The author originally undertook the preparation of quinonetetra-carboxylic acid, $C_6(O_2)(CO_2H)_4$, in order to compare it with croconic acid, which has the same percentage composition, the constitution of which was undetermined at the time when the experiments were commenced; the results are entirely confirmatory of the conclusion that croconic acid is not a benzene-derivative.

All attempts to oxidise durenequinone, $C_6(O_2)(CH_3)_4$, proving unsuccessful, durylic acid, $C_6H_2(CH_3)_3{\cdot}COOH$, was converted into dinitrodurylic acid, from which by oxidation with permanganate the tetracarboxy-acid was prepared; and ultimately this was converted into quinonetetracarboxylic acid. The preparation both of these compounds and of a variety of intermediate products and derivatives and their properties are fully described in the paper: a portion of the results have already been published in the *Annalen* (ccxxxvii., 1; *c.f. Chem. Soc. Abs.*, 1887, 255).

Ethylic diamidotetracarboxylate, from which the quinone carboxylate was obtained by oxidation with nitric acid, closely resembles the allied diamidoterephthalate studied by v. Baeyer; on reduction it is converted into a hexahydrobenzene-derivative — ethylic paradiketohexamethylenetetracarboxylate,—

$$CO\left\langle\begin{matrix}CH(CO_2Et){\cdot}CH(CO_2Et)\\ CH(CO_2Et){\cdot}CH(CO_2Et)\end{matrix}\right\rangle CO.$$

Ethylic quinone tetracarboxylate has a yellow colour, but is odourless; it sublimes readily without decomposing, and is scarcely acted on even by prolonged heating with concentrated nitric acid. Ethylic quinoltetracarboxylate, $C_6(OH)_2(CO_2Et)_4$, prepared by reducing the quinone with zinc-dust and acetic acid, is a very remarkable substance: on further reduction it is converted into the paradiketohexamethylenecarboxylate, which most closely resembles Herrmann's ethylic succinosuccinate; it exists apparently in three distinct modifications, only two of which, however, have been studied: the one modification is green and crystallises in needles; the other is pale yellow and crystallises in plates; after fusion and cooling, the former appears dark yellow, the latter bright yellow. If either modification be separately dissolved in carbon bisulphide, a solution is obtained from which the two substances crystallise out together; the solution has the same colour and the same absorption-spectrum whichever modification be dissolved. In the paper the author calls attention to a number of similar cases of dimorphism. Quinoltetracarboxylic acid has a pale yellow colour, and yields yellowish metallic salts which exhibit a characteristic green fluorescence; it is not converted into quinonetetracarboxylic acid by oxidising agents: a similarly remarkable resistance to conversion into the corresponding quinone-derivative has been observed by the author in the case of quinolcarboxylic acid.

25. "*The Action of Acetone on Ammonium Salts of Fatty Acids in presence of Dehydrating Agents.*" By S. Ruhemann and D. J. Carnegie.

As chief product of the interaction of acetone and ammonium acetate in presence of phosphoric anhydride, the authors have obtained a base of the formula $C_9H_{15}N$, which they find is identical with the dehydrotriacetonamine discovered by Heintz. On treating the compound $C_9H_{15}N$ with bleaching-powder solution, it gave an unstable chlorinated derivative: on submitting this to the action of alcoholic potash a liquid (b.p. 78° to 79°) was obtained which the authors regard as a new isopropyl alcohol hydrate of the formula $C_3H_8O{\cdot}OH_2$. The same substance was produced on substituting formate and butyrate for the acetate: hence it follows that only the ammonia of the salt is concerned in the formation of the base.

26. "*A Method of Estimating Nitrites either alone or in presence of Nitrates and Chlorides.*" By T. Cuthbert Day.

The method consists in saturating the solution containing the nitrite with solid ammonium chloride, boiling the mixture in a suitable apparatus, after removal of the air by carbonic anhydride, and collecting and measuring the nitrogen evolved; interaction takes place according to the equation $NO_2K+NH_4Cl=KCl+2OH_2+N_2$, hence the quantity of nitrite present in the substance under analysis is calculated from half the volume of nitrogen obtained.

The Anniversary Meeting will take place on Wednesday, March 28th, at 8 p.m. The President will deliver an Address on "Elements and Meta-Elements."

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

Annual General Meeting, March 1st, 1888.

Address of the President, Dr. Odling, M.A., M.B., F.R.S., &c.

In the Anniversary Address which it was my privilege to deliver a twelvemonth ago, I was able to announce to the Fellows and Associates then present, that the bye-laws of the Institute, as made, revised, and confirmed at successive general meetings, held on or between March 26th, 1886, and February 15th, 1887, had, shortly before the occasion of our then anniversary, been rendered effective, by reason of their having received the formal allowance of the Lords of the Privy Council; and that, from that time forth, the conduct of the affairs of the Institute would have to be, as I need scarcely say it has since been, in accordance with the provisions of the bye-laws. These bye-laws, however, are far from being the sole or even the main authority under which the Institute of Chemistry carries on its functions as a Chartered Corporation. Even its authority to make bye-laws at all is limited by the conditions of the Charter; and it was for the Lords of the Council, among other things, to satisfy themselves that these conditions were strictly fulfilled. Accordingly, for a declaration broadly of the objects, constitution, and duties of the Institute, we have to look to the words of the Charter, wherein is accorded, among other powers, the power to make bye-laws, primarily for all or any of certain specific purposes set forth in the Charter; and then, more generally, such bye-laws as from time to time seem "requisite for the management and regulation of the affairs and property of the Institute, and the better execution of this our Charter, and the furtherance of the objects of the Institute." This last expression, "the furtherance of the objects of the Institute," has reference of course to its declared objects, as stated in the petition serving afterwards as the preamble of the Charter,—these objects being referred to in the Charter itself as "laudable and deserving of encouragement." One of these objects, and, indeed, the one most of all dwelt upon, is declared to be "the elevation of the profession of consulting and analytical chemistry;" and the strongest ground put forward, on behalf of our claim then being made for incorporation, is expressed in these words, that "besides other advantages such incorporation by Charter would be a public recognition of the profession of analytical and consulting chemistry, and would tend gradually to raise its character, and thus to secure for the community the existence of a class of persons well qualified to be employed in the responsible and difficult duties often devolving on them." Believing in the sincerity of the representations so made, namely, that our main object was the elevation of the profession, and that our incorporation as a chartered body would tend to effect that object, the coveted Charter, with power

to make bye-laws, was after some consideration accorded us; and, by the allowance finally granted to our code of bye-laws, we were enabled to make our proper start, without further let or hindrance, a twelvemonth ago, so that we are now, as we were not until then, fairly on our way.

Being, however, thus fairly started on our way, it only remains for the members of the Institute to fulfil the obligation they have taken on themselves to make the elevation of the chemical profession an object of real solicitude, and to render their at length completed organisation serviceable towards the achievement of this end. Now that the Institute of Chemistry takes its place among the recognised professional associations of the kingdom, it is for the members to determine whether it shall take a prominent place,—whether or not it shall take that place to which its character as the embodiment of one of the most scientific of all professions entitles it. Every professional association has the special conditions of its own craft to take into consideration, its own special advantages to make good use of, and its own special difficulties to contend with. But all professional associations, old and new alike, would seem to have this in common, that they owe their ultimate success and influence, in large measure, to those who, taking a high view of their profession, believed in and worked for its future, and discarding ignoble motives, were determined, that come what might, that future should be a progressive and a distinguished one. Admitting, as we must, that human action is ever the result of mixed motives, from which the great motive of self-interest cannot, as it ought not, to be excluded, there is yet all the difference in the world between an intelligent and widely sympathetic self-interest on the one hand, and a low and confined self-interest on the other; between the self-interest which is consistent with the desire and ambition to achieve a common good, and the narrow self-interest which looks only to a present and purely personal gain. That the Institute of Chemistry, developed in a liberal and enlightened spirit, may and will become the means of conferring real benefits upon those engaged in the practice of professional chemistry—that it will at any rate achieve for its members no less of good than other well-regarded professional associations have achieved for theirs—does not, I think, admit of question; and on this point I propose to say a few additional words further on. But it was never intended to effect advantages of a purely personal kind; and in justifying the claim which we made to be intrusted with a Charter, the idea that we had any such personal advantages in view was only mentioned to be at once repudiated. By our acceptance of the Charter, granted as it was in the terms of our own application, we are pledged to make the Institute subservient to public and not to private ends. But alike on public and private grounds, we desire to make it a respected and influential organisation, not unworthy of the eminently scientific profession which it claims to represent. Great and powerful institutions, however, are not to be looked for as the outcome of paltry aims, but rather of earnest single-minded effort on the part of those animated by the sense of a high and worthy purpose to be achieved.

The Institute of Chemistry differs from, at any rate, the greater number of professional societies in this, that its organisation was from the first, as it still is, essentially democratic. The majority of these societies have been, not a few of them still are, more or less oligarchic. They were founded and fostered, for the most part, by men of mark in their several professions, fully conscious of their own powers and attainments, earnest and high-minded beyond all question, but a little perhaps out of sympathy with the rank and file of their brethren. In most of the older societies, and in several not so old, the rank and file have had to fight their way, not so much for corporate equality as even for recognition. In the foundation and conduct of the Institute of Chemistry, this condition of things has not obtained, or rather has been almost reversed. Not indeed without the hearty co-operation of several of the more prominent of our body, the original association founded in 1877, of which the present Institute is the outcome and development, was originated mainly by the then younger and less prominent men among us. And the idea from the first, was the comprehension of all engaged in the different departments of chemical work on a footing of corporate equality. It was in accordance with this idea of the union of the entire existing profession, that so soon as we were able to act under our bye-laws, a general announcement was made of our desire to associate with ourselves, to whom the charter was primarily granted, all qualified professional chemists in practice throughout the country, who reciprocally had a desire to associate themselves with us. It is not to be denied that the step thus taken, though supported by a weighty preponderance of favourable opinion, has been objected to by several individual Fellows. It was felt, however, that the Charter of Incorporation was intended for the benefit of the entire profession, and that its use in any spirit of exclusiveness, by those to whom it was primarily granted, would be not only unwise, but altogether unjustifiable. Anyhow, the step has been taken; and with the result that our corporation has been increased by an addition of about two hundred new members, whom I beg to assure we are heartily glad to welcome among us. Thus reinforced by combination, it remains for us all, old and new members alike, to bear in mind the avowed paramount object of the Institute, namely, "the elevation of the profession of consulting and analytical chemistry." It is for us to show that the members of a profession organised like our own, in which the entire body is self-governing, are not less mindful of the real and permanent interests of our profession than are the oligarchic few who, in so many instances, constitute the governing bodies of other professional societies. Surely, in our case, it is for the self-governing many to show a like spirit of earnestness and high purpose to that manifested in other cases by the exclusive few; who, stimulated by the sense of their position and responsibility, have devoted themselves with so much persistency and zeal to raise their respective societies to the height of influence and reputation which several of them at present enjoy.

As in other societies, the executive Council of the Institute of Chemistry is subject to an annual excision and filling up of its numbers. Every year one-third of the Vice-Presidents, and one-third of the ordinary Members of the Council become ineligible for re-election. The formal nomination of the new Vice-Presidents, and of the greater part of the new ordinary Members of Council, rests, as in all other societies, with the pre-existing Council; and I venture to think advantageously so. In filling up their list of nominations, the Council, purposely met to deliberate on the matter, have to take into account, and do take into account, a number of more or less conflicting considerations,—the object desirable to attain being clearly the selection of a Council as thoroughly representative and useful as possible. Thus it is obviously desirable that the Council should include representatives of the several divisions of the United Kingdom; or, in other words, that Scotland and Ireland should not be forgotten; as neither should, apart from the question of nationality, the great provincial centres of chemical industry, as Glasgow, Newcastle, Manchester, Liverpool, Birmingham, and Bristol. It is clearly desirable also to include prominent representatives of the different scientific or professional societies, with whom we are most closely in association, as the parent Chemical Society, the Society of Chemical Industry, the Society of Public Analysts, and the Pharmaceutical Society. Again the multifarious departments and varieties of professional chemistry have to be considered. Professors and teachers of chemistry, to whom we look for our successsion of associates; chemists occupying official positions of all kinds; chemists to works and mercantile associations of different kinds; chemists engaged chiefly in the analysis of various

commercial and manufacturing products; chemists engaged chiefly in consulting practice; chemists who have not, and chemists who have previously served on the Council; and above all, those who, interesting themselves warmly in the success of the Institute, possess the knowledge and experience of affairs which makes their co-operation in the work of the Council pre-eminently advantageous. These and such-like considerations are discussed and acted upon at the meeting of Council, at which, after due notice, the selections for nomination are made by ballot, —I would have said at the usually full meeting of Council, but for the circumstance that all our meetings of Council are usually full meetings.

From the number and variety of not always obvious considerations involved, it is likely enough to happen that the selection made by the Council, though susceptible of easy justification, may not always justify itself on mere inspection. Having regard, however, to the different interests that have to be taken into account, it would seem, I think, to most, that the nomination of new Members of Council is better thus left in the hands of some two dozen or more responsible persons, necessarily representative of various departments of chemical work, rather than to the hap-hazard nomination of scattered individuals, or to the joint nomination, with a view to some sectional object, of some particular group of members. On the other hand, any body of men who constitute an executive Council, with the power of nominating to the statutable vacancies created in their body, are admittedly liable, however unconsciously, to act in a greater or less degree under a feeling of clannishness; and are yet more liable to suffer under the imputation of so acting. To counteract this tendency, so far as it may exist, and still more to maintain a common interest and feeling of mutual confidence between the Council and the general body of the Fellows, a special provision has been made in the Bye-laws of the Institute, which is not, I think, to be found in the Bye-laws of any other corporation. By this provision, while the formal nomination of two-thirds of the new ordinary Members of Council is left in the hands of the pre-existing Council, the formal nomination of the other third is left in the hands of the general body of the Fellows. And by exercising this right year after year, as it is advisable it should be exercised, the outside body of Fellows become the nominators of one-third of the ordinary Members of Council or of one-fourth of the entire Council,—this one-third or one-fourth having further its proportionate voice in the selection by ballot of the members primarily nominated by the Council. Considering the variety of interests that have to be taken heed of by the Council in making their primary nominations, necessarily of persons not at all likely to think or act in unison with one another, it is evident that the power of the outside body of Fellows to nominate one-third or one-fourth of the Council gives them a very influential, if not indeed a preponderating, voice in its deliberations. As a matter of experience, there has not been found any party division, or general difference of view, between Members of Council nominated by the general body of Fellows on the one hand, and those nominated by the pre-existing Council on the other. But supposing such a division on party lines to exist, and the nominees of the general body to have been out-voted or treated with scant consideration, in respect to some question regarded as of importance which they had formally brought under the notice of the Council, they might under such circumstances justifiably, and I think only under such circumstances, hitherto quite hypothetical, make their appeal to the general body; and a little consideration will suggest how such an appeal should and how it should not be made. It cannot be too fully recognised that the entire body of members of the Institute constitute the governing body of the Institute, and that the Council form only the administrative executive. It is of course open to each individual Fellow, and still more to any set of Fellows, to bring under the formal consideration of the Council any view or proposal in which they are interested; nor are they bound to acquiesce in its rejection by the Council, should it so fall out. On any matter deemed of sufficient importance, whether or not previously brought under the consideration of the Council, it is in the power of any twenty members of the Institute to have a general meeting called to consider such matter, and, after all sides have been fully heard, to express thereon a decision which it is imperative on the Council to give effect to. It is for the general body of Fellows to consider whether this method of proceeding, specially provided for in the Bye-laws, is not more straightforward and befitting than any kind of attempt by means of *ex parte* representations, to pack a Council with the advocates of some particular view or sectional interest. It is, of course, for the general body to select whomsoever they please as the Officers and Council of the Institute, and circumstances are conceivable in which they might be warranted in a more or less wholesale rejection of the Council list; but having regard to the mode of constitution of the Council, the duties imposed on them, and the support to which they are entitled in fulfilling these duties, such a proceeding would seem to be justifiable only as a last resource, and on some specific grounds of unwise or wrongful action, held to be such by an undoubted preponderance of opinion among the Fellows as a whole. I have enlarged on this topic more fully than I otherwise should from the strong feeling I am under as to the paramount necessity of maintaining a sense of common interest and purpose between the Council and the Fellows at large. With all the failings naturally incident to a system of virtual co-optation, it is yet clear that the duty of making nominations to the Council is a charge for which some set of persons possessing the confidence of the Fellows in general must be responsible; while by means of the special provision, requiring the acceptance by the Council of outside nominations to the extent of one-third the number to be made, any section of the Fellows deeming themselves insufficiently represented have it in their own power to supply the deficiency.

(To be continued.)

NOTICES OF BOOKS.

Modern Theories of Chemistry. By Dr. Lothar Meyer, Professor of Chemistry in the University of Tübingen. Translated from the Fifth German Edition, by P. Phillips Bedson, D.Sc., B.Sc., F.C.S., and W. Carleton Williams, B.Sc., F.C.S. London: Longmans, Green, and Co.

For a long time no general exposition and appreciation of chemical theories has been open to the English reader. "Daubeny on the Atomic Theory," which was of value forty years ago, is now hopelessly out of date. We are, therefore, no little indebted to Drs. Bedson and Williams for their version of Prof. Lothar Meyer's great work. Great we call it, not in reference to its extent, but to its value as presenting a clear, a judicions, and a fair survey of the entire field.

The work, if we leave out of view the elaborate introduction, which is in itself well worth reading, is divided into three parts—"The Atoms," the "Statics of the Atoms," and the "Dynamics of the Atoms."

In the first of these great sections the author shows the necessity for the atomic hypothesis, explains the difference between atoms and molecules, and discusses the methods by which the relative weights of the former may be determined. Their actual or absolute weights have not, he admits, been determined with a sufficient degree of accuracy. Here, too, at the very outset, he admits the essentially close relation existing between the properties of an element and its atomic weight.

In successive chapters he discusses the aids employed

in the determination of atomic weights, such as the specific gravity of gases, under which head is included a consideration of the relation between the atomic and the molecular weights of the elements, and the specific heat in the solid state. He then comes to the "chemical atoms" themselves. We find him admitting, as probable, that "as the masses which perceptibly occupy space are composed of molecules, and molecules or particles of the first order are composed of atoms or particles of the second order, so atoms are composed of particles of a third or simpler order."

He further admits the improbability of the existence of some sixty or more entirely different forms of primordial matter. But into the grand question of the origin of the elements he does not seem disposed to enter. Nor does he weigh the evidence for or against their primordiality as commonly received. In the meantime he is naturally led to review the hypothesis of Prout. Here, whilst showing that the investigations of Marignac and Stas give results not in exact accordance with the demands of this theory, he refers to the remarkable fact, emphasized by Marignac, that a large majority of the atomic weights are almost exact multiples of the atomic weight of hydrogen. This, Prof. Meyer thinks, can hardly be purely accidental. He suggests, therefore, that the atoms of many at least of the elements consist chiefly of smaller particles of one distinct primordial form,—perhaps hydrogen,—and that the weights of the atoms do not bear a simple relation to one another because they contain, in addition to particles of this primordial matter, varying quantities of the matter which fills space, and known as the luminiferous ether, which is perhaps not quite devoid of weight.

Hence we are naturally led to an examination of the relations subsisting between the atomic weights of the respective elements, and ultimately to the periodic theory. This subject is here worked out at great length, and with constant reference to original authorities. There is one point only to which we regret having to call attention:—We are unable to find any mention of Mr. J. A. R. Newlands as the original propounder of the periodic classification. His name, indeed, occurs once only, and that in the following connection:—"Since Leopold Gmelin, in 1826, called attention in his treatise to relations of this description, the subject has been frequently discussed by different chemists, more particularly by Max Pettenkofer, J. J. Dumas, P. Kremers, J. H. Gladstone, J. P. Cooke, Low, W. Odling, E. Lenssen, J. Mercer, M. C. Lea, J. A. R. Newlands, Carnelley, Crookes, and others." No one, surely, reading this passage, and having no more precise information on the subject, would in the least imagine the position of Newlands! Nor have the translators, who must be fully aware of the facts, rectified this error in a footnote.

Some of Prof. Meyer's remarks in connection with the periodic law, and in general with the quest for numerical relations, are of great value. Thus he writes:—"Numerical relations were sought for where they did not exist, and, what was much more dangerous, the values obtained by experiment were frequently altered in order that they might exhibit relations not warranted by direct observation."

He considers that "in all these speculations we must not lose sight of the fact that the general law upon which the relations between the properties of an element and its atomic weight depend is still unknown." He pronounces it beyond doubt "that the system of the elements based upon the values of their atomic weights will form the basis of future doctrines of comparative affinity."

The prize of discovery here, the author tells us, is "a systematic inorganic chemistry which will not fear comparison with the thoroughly developed system of organic chemistry." But is this all? There are inquirers who are hoping and working for something further!

The two subsequent parts of the work, into which space does not allow us to enter, deal with the statics and the dynamics of the atoms.

We must pronounce this work to be the nearest existing approach to a philosophy of chemistry,—perhaps the nearest possible in the present state of our knowledge.

CORRESPONDENCE.

INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—Mr. Thomson's letter (Chemical News, vol. lvii., p. 110) has one statement in it which deserves notice, and that is:—"Upwards of two-fifths of those who voted at the Annual Meeting were in favour of the changes we suggested in the Council."

The numbers read out were—For the Council list, 158; against, 102 or 105, I am uncertain which.

Now to my knowledge many of those present voted against the Council list simply by striking out Mr. Thomson's name as a protest against his action. All these are included in the minority. I was told in the room, by a gentleman who had means of knowing, that the number of men who voted for Mr. Thomson's list was less than 30, which is (say) 11 per cent of those present either personally or by proxy, and less than 5 per cent of the total number of members.

Mr. Thomson seems to think it strange that his circular was looked on as unfriendly by the Council, and he deprecates any desire to hurt their feelings. The Council may accept this expression in all sincerity; but had Mr. Thomson's scheme proved successful they might well have said, with Bickerstaff, in "'Tis Well it's No Worse,"—

> "Perhaps it was right to dissemble your love,
> But why did you kick me downstairs?"

For the rest I commend paragraph *six* of Mr. Thomson's letter to the careful consideration of all Fellows of the Institute. Not only being a "professor," but having been one is a disqualification; after seeing which one is not surprised to find "5 manufacturers" and 6 holders of "Government appointments" on Mr. Thomson's *Index Expurgatorius*.

This, read with the letter of A. F. W., in the same issue, shows which way the wind blows. Those who wish to see the representative body of professional chemistry something more than an analytical chemists' trade union have had fair warning.—I am, &c.,

R. J. Friswell.

115, Darenth Road, Stamford Hill,
March 18, 1888.

INSTITUTE OF CHEMISTRY.

To the Editor of the Chemical News.

Sir,—Mr. W. Thomson, in his letter in the Chemical News (vol. lvii., p. 110), says "The fact that upwards of two-fifths of all those who voted at the Annual Meeting *were in favour of the changes we suggested in the Council*" (the italics are mine) "is some guarantee that, if our movement is a party one, the party is a very large one."

Now it is a fact "that upwards of two-fifths of all those who voted at the Annual Meeting" did not vote in favour of the list issued by the Council, but it does not by any means follow that these two-fifths were in favour of the changes advocated by Mr. Thomson. It does not seem to have occurred to Mr. Thomson that many—possibly a considerable proportion of that two-fifths—altered the Council list by striking out Mr. W. Thomson's name, and substituting that of some other member whom they considered more likely to maintain the dignity of the Institute. The proxies might be a safer guide, and I was told that those held by the President and Secretary were more than four times as numerous as those in favour of Mr. Thomson and his friends.—I am, &c.,

One who was There.

March 19, 1888

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 9, February 27, 1888.

Artificial Production of Rhombohedric Crystals of Rubies.—E. Fremy and A. Verneuil.—The authors submitted to the Academy rhombohedric crystals obtained by the method which they described in the session of March 14, 1887. This method consists in causing barium fluoride to react at a red heat upon alumina containing traces of potassium bichromate. The regularity of the crystallisation is due to the management of the fire. The crystals are found imbedded in a porous and friable gangue, and may be separated by throwing the entire mass into a bottle of water and agitating briskly, when the rubies, on account of their higher specific gravity, subside to the bottom and rarely require to be purified by treatment with acids. No trace of barium is present. They easily scratch the topaz; like genuine rubies, they blacken if heated and resume their rose-red on cooling.

Crystalline Form of M. Fremy's Rubies.—M. Des Cloizeaux.—Each operation seems to give rise to predominating forms which vary from one preparation to another. The forms examined and measured cannot be clearly described without the accompanying diagrams.

Certain General Conditions of the Fixation of Nitrogen by Vegetable Mould.—M. Berthelot.—The fixation of nitrogen seems to be effected in the form of complex organic compounds. The conditions of fixation are a high degree of porosity; a proportion of water not exceeding 12 to 15 per cent, and not falling below 2 or 3 per cent; the presence of oxygen, since the active microbia are ærobic, and a temperature like that of summer, but not exceeding 40° to 45°. In winter the process is arrested. The fixation, at least in soils without vegetation, has a limit, so that the proportion cannot exceed 1·68 grms. per kilo. of dry soil.

A Process for Determining Chloroform, and on the Solubility of this Body in Water.—G. Chancel and F. Parmentier.—The authors claim precedence as regards the method given by M. L. de Saint-Martin (*Comptes Rendus*, vol. cvi., p. 493).

On the Laws of Chemical Equilibrium.—H. Le Chatelier.—A mathematical paper which does not admit of useful abstraction. The author combats the views of M. Duhem (*Comptes Rendus*, Feb. 13, 1888).

Novel Hydrate of Molybdic Acid.—A. Vivier.—The ordinary yellow hydrate of molybdic acid contains 2 mols. of water. The author has succeeded in transforming this yellow hydrate into a white monohydrate by heating it for some days to 50° to 60° in the nitric solution of ammonium molybdate diluted with an equal volume of water.

The Vapour-density of Aluminium-methyl.—E. Louise and L. Roux.—The vapour-density of this compound, $Al_2(CH_3)_6$, is 5·02. The organic compounds of aluminium, when destroyed by heat, yield metallic aluminium and a mixture of hydrogen and of the ethylenic and formenic hydrocarbides.

Action of Aniline upon Epichlorhydrine.—Ad. Fauconnier.—The author has re-examined the results obtained by Hörmann, and has succeeded in isolating one of the bases mentioned by the latter, which he names dianilglycerin.

Bulletin de la Société Chimique de Paris. Vol. xlviii., Nos. 4 and 5, Sept. 5, 1887.

On Certain Selenites.—M. Boulzoureano.—The author describes five methods for the preparation of these salts, and gives an account of cobalt, nickel, manganese, and cadmium selenites.

On the Bromobenzenes.—A. J. Leroy.—An account of the mono- and di-compounds, and of the action of aluminium chloride upon para-dibromo-benzene.

Ethyl-propyl-acetylene, a New Substituted Ethylenic Carbide; its Hydration.—A. Béhal.—The compound in question, $C_7H_{14}O$, has at 0° the sp. gr. 0·83. Nitric acid colours it an intense blue, which disappears if the temperature is raised.

MISCELLANEOUS.

Is a Safe now a Safe?—At the meeting of the Liverpool section of the Society of Chemical Industry, on Wednesday, March 7th, Mr. Thomas Fletcher, F.C.S., gas engineer, of Warrington, gave a demonstration of the application of some new gas heating appliances, devised by himself for workshop emergencies, one of the feats of the evening being the fusion of a large hole in a plate of ¼ inch thick wrought iron, in a few seconds, without preparation, and with apparatus which could be carried by a man up a ladder and used in any position. The Secretary, in the discussion which followed the experiments, raised the very serious point that with such apparatus as Mr. Fletcher had exhibited and used, a burglar proof safe no longer existed, as it was simply a question of minutes to fuse a hole large enough for a man to enter in any wrought iron or steel door in existence. Chilled iron or steel were powerless to resist the small blow-pipe Mr. Fletcher used, which would penetrate thick iron and steel plates as readily as ordinary carpenter's tools would penetrate wooden doors. The apparatus was devised by Mr. Fletcher for works repairs, and was noisy in action; but, as he explained, the apparatus could be made silent, and small enough to carry in a hand-bag. This is a very serious matter for bankers and others who have valuable property, and one which will have to be taken up at once by the safe and strong room makers. It is very well-known that the professional burglar is ready to utilise the latest applications of science for his own ends; in fact, Mr. Fletcher's furnaces designed to assist in chemical research are well-known as being used by receivers of stolen goods to reduce plate and jewellery to ingots, and these furnaces may be seen in the detectives' museum at Scotland Yard. Bankers have already taken the alarm, and have visited Mr. Fletcher's works with the object of seeing the extraordinary ease with which large openings can be fused in heavy iron or steel plates. It is hardly necessary to say that Mr. Fletcher plainly declares his intention not to devise a silent form of the apparatus, which naturally would be required only for burglar's use, but the light-fingered profession will no doubt take the matter in hand, and most probably succeed in making the apparatus silent, a modification which Mr. Fletcher states can be made. During our own interview with Mr. Fletcher on this very serious matter, he informed us that the present danger is possibly not so great as it appears, owing to the fact that the apparatus necessary to manufacture and prepare the silent arrangement is both costly and large, and as the person who prepares it must have fixed machinery and plant, he will most probably be one of the last to whom the enterprising burglar would apply for his apparatus.—*Warrington Guardian.*

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Incrustation in Boilers.—Can any of your readers tell me if there is any objection to the addition of muriatic acid to a well water which is used for boiler purposes? I find that the incrustation is very much reduced by the above addition. Of course care would be taken not to have any excess of free acid present in the boiler.—W. R.

Colouring Matters of Decaying Wood.—Can any of your readers give me a few references to any literature on this subject either English or foreign? I am specially interested in the bright green colouring matter to be observed in partly decayed fallen branches of trees in dry forest litter.—A. Irving, Wellington College, Berks, March 17, 1888.

MEETINGS FOR THE WEEK.

Monday, 26th.—Medical, 8.30.
— Society of Arts, 8. "Alloys," by Prof. W. Chandler Roberts-Austen, F.R.S.
Tuesday, 27th.—Royal Medical and Chirurgical, 8.30.
— Institution of Civil Engineers, 8.
— Society of Arts, 8. "The Panama Canal," by J. Stephen Jeans
Wednesday, 28th.—Geological, 8.
— Chemical, 8. (Anniversary). President's Address. Election of Office Bearers.

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ST. PAUL'S SCHOOL.—An Examination for filling up about Four Vacancies on the Foundation will be held on the 11th of April, 1888, and following days.—For information apply to Mr. S. Bewsher, Bursar, St. Paul's School, West Kensington.

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TO CHEMISTS.

The Directors of the Sheffield United Gas Light Company require a Chemist. One who has a knowledge of Gas Works preferred. He will be required to make analyses of gas residuals and various products therefrom, and of all materials used in the manufacture of gas or in connection therewith. The whole of his time must be devoted to the service of the Company.

Applications (marked "Chemist"), stating qualifications, age, salary required, previous engagements, &c., to be sent in not later than April 5th, addressed to Sir Frederick T. Mappin, Bart., M.P., the Chairman of the Company.

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Chemist, who has studied in Germany, and who has had considerable experience in Works and Laboratories, is desirous of entering a Business, with management or part management of same, and with a view to future partnership.—Address, A. C., Chemical News Office, Boy Court, Ludgate Hill, London, E.C.

Wanted, an Assistant with some knowledge of the Analysis of Limestones, Clays, &c. State age, experience, and salary required; and address, by letter only, to L. C., care of Mr. Windle, 1, Great Queen Street, Westminster.

Well-fitted Laboratory, in a good part of London, to be Disposed of.—Address, X. Y. Z., Chemical News Office, Boy Court, Ludgate Hill, London, E.C.

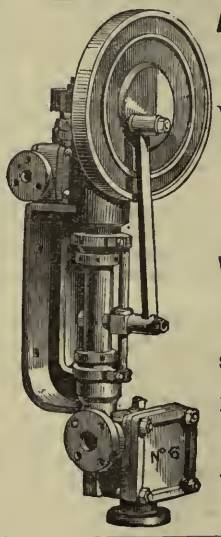
BARCELONA EXHIBITION.

At the Request of the Secretary of State for Foreign Affairs, the Society of Arts have undertaken to receive applications for space from intending English Exhibitors. The Authorities of the Exhibition have agreed to consider applications for space (except for Machinery) until the end of the present month.

Further particulars and Forms of application for space can be obtained on application to the undersigned.

H. TRUEMAN WOOD, Secretary.

Society of Arts, John Street, Adelphi, London, W.C.



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THE CHEMICAL NEWS.

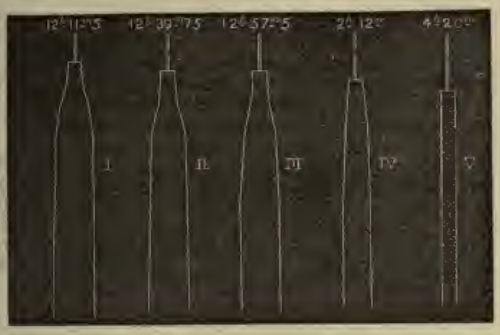
Vol. LVII. No. 1479.

ON THE RANGE OF MOLECULAR FORCES.*

By A. W. RÜCKER, M.A., F.R.S.

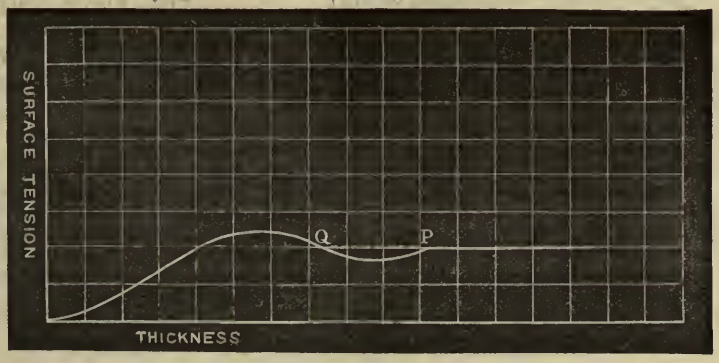
(Continued from p. 115).

The accompanying figures represent the life history of a film which Professor Reinold and I watched for several hours. They are sections deduced from the colours observed at intervals. The thickness is magnified 5000 times more than the length. The upper part of the film was black and the enormously rapid change in thickness at the edge of the black is well shown.



Sir William Thomson (*Proc. Roy. Instit.*, xi., Part III., 485, 1887) and Professor Reinold and myself (*Phil. Trans.*, clxxvii., Part II., 679 and 684, 1886) independently arrived at the conclusion that our observations on the uniform thickness of the black part of a film and on the discontinuity in the thickness at its edge prove that when the film reaches a certain degree of tenuity the surface-tension diminishes to a minimum, and begins to increase again when the thickness is somewhat greater than 12 $\mu.\mu$.

The relation between the surface-tension and thickness may thus be represented by a curve like that shown in the accompanying figure. When the thickness is great the surface-tension is constant. When it reaches the value which corresponds to P, the tension begins to diminish. The thicker parts of the film now tear the thinner parts asunder. Rupture would inevitably follow were it not for the fact that when a certain degree of tenuity is reached the surface tension again increases, and when the thickness is 12 $\mu\,\mu$. becomes equal to that of a thick film, as indicated by the quality of the ordinates at P and Q. Equilibrium is thus possible between two parts of a film of which the one has the thickness corresponding to Q, and the other any thickness greater than that corresponding to P. It is also stable, for any further decrease in the thickness of the film below would cause a further increase of tension. The thinner parts would therefore contract and become thicker. In other words the film could not, under ordinary circumstances, thin to below that thickness for which the surface-tension regains its normal value. The discontinuity at the edge of the black, and the uniform thickness of a black film, are thus both accounted for. Our failure to detect any measurable difference of surface-tension between thick and thin films means not that the radius of molecular action is less than 12 $\mu.\mu.$, but that the changes of tension which produce the sharp edge of the black are certainly $< 0{\cdot}5$ per cent of its whole value.



Let us then examine this remarkable phenomenon a little more closely. It is a result of ordinary observation that in a thinning film there is a range of unstable thickness, which is always missing between the black and coloured parts. The instability is very strikingly shown by an experiment which Professor Reinold and I have often performed. If an electric current be sent up a cylindrical film, the upper part of which is black, the sharp edge is obliterated. The current carries liquid up with it, smoothes off the discontinuity, and the colours pass into the black by a gradual transition through grey.

As soon, however, as the current is broken, the old state of things is re-established. The grey disappears, and the black is again bounded by a definite sharp edge. The change takes place in from ten to sixteen seconds. The colours which thus vanish correspond to the range of unstable thickness. Its lower limit is fixed by the experiments of Professor Reinold and myself as being nearly 12 $\mu\,\mu$. The upper limit is more difficult to determine, as the colour by which the black part of the film is bordered varies, and is probably largely determined by accident.

This, however, may certainly be said, that when the film thins in the normal way the discontinuity in the thickness never occurs within the grey region. The colour next to the black may rise into the second or higher orders; it never sinks below a full white of the first order. It is, therefore, probable that the decrease in surface-tension begins at a thickness less than that which corresponds to the middle of the white, and greater than that which corresponds to the beginning of the black or faint blue which surrounds it. According to Newton these thicknesses are 96 and 45 $\mu\,\mu$. respectively, the mean being 70 $\mu.\mu$. Let us now assume that Quincke's value of the radius of molecular action is correct. The greatest possible thickness at which the surface-tension of a film could begin to diminish is then 100 $\mu.\mu$. Any film thicker than this would have two complete surface layers, and a layer of "interior" liquid separating them. Its surface-tension could not therefore depend on the thickness. On the other hand, if Maxwell's theory were correct, the

tension would remain unaltered until the thickness was equal to the radius of molecular action, *i.e.*, 50 $\mu.\mu.$ It is not, I think, probable that any improvement in the theory would reduce this limit, though it might increase it. Hence we arrive at the conclusion that *the limits of thickness fixed by observation as those between which the surface-tension of a film begins to diminish* (96 *and* 45 $\mu.\mu.$), *are practically identical with the limits deduced by theory from Quincke's experiment* (100 *and* 50 $\mu.\mu.$) *as those within which such decrease ought first to be observed.*

Curious and important as I venture to think this conclusion is, I do not wish to press it too far. The fact that the limits of doubt imposed by two independent lines of argument are at the present moment the same, is a more or less accidental coincidence. The vital point is that the value of the radius of molecular action as determined by Quincke, is certainly of the same order as, and cannot possibly differ much in magnitude from that which may be deduced from the properties of soap films. Quincke's result is, therefore, not an isolated fact. It receives the strongest possible confirmation from a totally different line of research. The matter may also be presented in another way. The radius of molecular action cannot, if Maxwell's theory be accepted, be greater than 96 $\mu.\mu.$, which is the superior limit to the thickness at which the surface-tension begins to decrease. If the ordinary view be correct, it cannot be less than one-half of 45 $\mu.\mu.$, which is the lower limit to that thickness.

Hence the true value of the radius of molecular action lies between 96 and 23 $\mu.\mu.$, and the value found by Quincke (50 $\mu.\mu.$) is intermediate to these.

However, therefore, we combine the figures, we deduce from the two observations the same result, viz., that 50 $\mu.\mu.$ is of the same order of magnitude as the radius of molecular action, a conclusion which it is not too much to say has now strong claims to rank as an ascertained fact.

Van der Waals† deduced from his theory distances between 0·15 and 0·29 $\mu.\mu.$, which are less, but as he thinks not very much less, than the radius of molecular action, and he expresses the opinion that Quincke's value is larger than our knowledge of capillary phenomena will allow. As the numbers he himself obtains are from 0·01 to 0·02 of the thickness of a black soap film, it is evident from the above discussion that they are very much too small.

Passing next to the lower limit of the unstable thickness (12 $\mu.\mu.$), we must enquire what is the cause of the increase of surface-tension to which the uniform thickness of the black film is due. On this point it may be well to speak with a certain amount of reserve until the theory of the constitution of liquids is more fully developed. If, however, we accept equations obtained by Maxwell, in which the movements of the molecules and the surface change of density are neglected, the phenomenon can be at once explained if we suppose that the increase of surface-tension corresponds to a change from attraction to repulsion in the intermolecular forces. If the force exerted by a liquid mass on a particle is repulsive when the distance of the particle from the surface lies between certain limits, then the tension of films, the thickness of which is comprised between the same limits, will increase instead of decreasing as the thickness diminishes. From this point of view, therefore, the explanation of the sharp edge of the black part of a soap film would be that when the molecular force between a liquid bounded by a plane surface and a molecule in its neighbourhood first becomes sensible, it is an attraction, but that at some lesser distance, which is nevertheless greater than 12×10^{-6} m.m., it becomes a repulsion. It must, however, be distinctly understood that the explanation that the increase in surface-tension is due to the action of a repulsive force is only put forward as suggested by Maxwell's theory. I think that this conclusion is very much more doubtful than that which determines the thickness at which the surface tension would begin to diminish, but further discussion of this point would involve a mathematical argument with which I will not at present trouble you.

If, however, apart from the question as to how it may be mechanically explained, the view be accepted that the surface-tension falls to a minimum, and is again increasing when the thickness is 12 $\mu.\mu.$, the very interesting question arises whether there is any experimental evidence that at some thickness less than 12 $\mu.\mu$ it again diminishes.

In answer it may be remarked that in general the black spreads slowly and quietly over the film, and may take an hour or more in travelling from the top to the bottom of a cylindrical film, 26 m.m. long. All the statements I have hitherto made refer to cases in which the mode of formation was thus normal (*Phil. Trans.*, clxxvii. [2], 677, 1886). At times, however, the black is formed into something like a convulsion. Not only does it spread with extraordinary rapidity, but the edge is violently disturbed, and large patches rise through the coloured part of the film. Whenever this occurs the film breaks before long, but in four cases we were able to obtain measurements before rupture. We are not able to produce this phenomenon at will, but the few observations we have been able to make on it are in agreement among themselves. In all cases the cylinder which thinned most rapidly bulged, the other contracted. The differences thus produced between the diameters varied from 0·35 to 0·75 m.m., and could not be accounted for by the sudden renewal of the surface of the thinning film (which would have produced a change in the other direction), or by any cause known to us. The measurement of the thickness of such films would probably settle the question as to whether the black when formed in this abnormal way corresponds to the state of unstable equilibrium which would exist if, after increasing, the surface-tension again diminished as the film became thinner, or to a second state stable within narrow limits of thickness. Such experiments would, however, be attended with extraordinary difficulties, as they would involve measurements on films which are practically always short-lived, and which are possibly theoretically unstable.

(To be continued.)

† "Die Continuität des Gasförmigen und Flüssigen Zustandes." Van der Waals. Translated by F. Roth. Leipzig, 1881 p. 107.

A NEW METHOD FOR THE SEPARATION OF TIN FROM ANTIMONY, AND ESTIMATION OF THE SAME IN SILICEOUS SLAGS AND ALLOYS.

By H. N. WARREN, Research Analyst.

The slags, essentially a silicate of iron, containing besides notable quantities of tungstic oxide, traces of lead, copper, and titanic oxides, are treated by the following method:—After careful grinding of 2 grms. of the slag, the portion is at once introduced into a platinum dish, and treated with an equal mixture of pure hydrofluoric and hydrochloric acids. The whole portion of the slag, after digesting for a few minutes, is entirely decomposed, the greater portion of the SiO_2 being volatilised as SiF_4, the remainder passing into solution and containing besides the whole of the tin as $SnCl_2$, besides other impurities: the solution, after being filtered, is gently heated and saturated with SH_2, the whole of the tin, besides the impurities present, being precipitated as sulphides; the precipitate collected is boiled with NaHO, to separate the bismuth and cupric sulphides present. The solution now contains pure sodio-sulpho-stannate of antimony and tin, which is re-precipitated by the addition of HCl; the antimony and tin sulphides now obtained are decomposed by means of aqua regia, and contain a large excess of HCl, both of

which pass into solution as antimonic and stannic chlorides. The solution evaporated to a small bulk, to deprive it of any large excess of HNO_3 that may be present, is diluted with a moderately weak solution of HCl; to the acid solution obtained an excess of potassium ferrocyanide is added, and the solution—which should now possess a clear blue colour, provided sufficient K_4FeCy_6 has been added—is allowed to boil. The whole of the tin is thus precipitated as stannic ferrocyanide, being insoluble in an acid solution, and, as there is no such compound as antimonic ferrocyanide, the antimony consequently remains in solution (which may afterward be precipitated by SH_2 and estimated in the usual manner). The precipitate containing the tin is now dried and ignited, a few drops of HNO_3 being added, which speedily destroys the organic matter present; the residue is now introduced into a crucible provided with a tubulated lid, and reduced by means of hydrogen or coal-gas, allowed to cool, and dissolved by means of HCl; the tin precipitated as sulphide, oxidised with HNO_3, and determined by the usual method.

The analysis and separation of tin from antimony in alloys may be conducted by precisely the same method, save that the alloy is dissolved by means of aqua regia in place of HCl+HF.

The precipitated antimony sulphide, after the separation of the tin by means K_4FeCy_6, should possess a bright reddish orange colour, entirely free from any brown colouration.

METHODS FOR THE SEPARATION OF IRON, NICKEL, COBALT, MANGANESE, ZINC, AND ALUMINIUM.

By THOMAS MOORE, Erdington.

In a former article (Chemical News, vol. lv., page 3) a description of a new process for the separation of iron from nickel was given, depending upon the formation of ferro- and nickelo-cyanide of potassium, and of their different reactions with bromine. Since then, however, the process has been modified and altered without affecting the accuracy of the results, so as to avoid the use of phosphoric acid, the presence of which might complicate matters, and at the same time to admit of its application to other separations.

Nickel from Iron.—To the cold concentrated (20 to 30 c.c.), and slightly acid solution, add an excess of solid sodic hydrocarbonate, in such quantity that after stirring a little remains undissolved, and nickel and iron both appear to be thrown down. Now add potassic cyanide until the precipitate dissolves, then heat gently until the pale yellow colour of the ferrocyanide is produced; at this stage the solution should be perfectly clear and free from any ferric hydroxide. Allow the liquid to cool; add a considerable quantity of a rather strong solution of potassic hydrate; then treat with chlorine, continuing the current of the gas until the green nickelous hydrate is completely converted into the nickelic hydrate and becomes perfectly black; after which it may be filtered off, and treated in the usual manner for electrolytic deposition.

Alumina from Iron, Nickel, or Cobalt.—Proceed exactly as above, and add a few drops of potassic hydrate to the somewhat turbid yellow solution until it becomes perfectly clear; then boil with the addition of ammonic chloride, when the alumina will be precipitated free from any of the other accompanying metals. The potassic hydrate and cyanide, as well as the sodic hydrocarbonate for this separation, should be tested for alumina and silica, impurities almost invariably present.

Manganese from Iron, Nickel, or Cobalt.—Add excess of sodic hydrocarbonate and potassic cyanide as already directed, and warm gently until the solution—which in presence of manganese has a dirty blue-green colour—becomes pale yellow and quite clear; then allow to cool, add a little potassic hydrate, and precipitate the manganese as peroxide by adding a little peroxide of hydrogen and leaving the solution in a warm place for a few hours. The peroxide, as is usual when precipitated from alkaline solutions, contains alkali, from which it is very difficult to free it by washing, so that it is best to dissolve in hydric chloride and precipitate as carbonate with ammonic carbonate. In order to avoid this inconvenience the cyanide solution may be precipitated by sulphuretted hydrogen, when manganese sulphide is rapidly and completely thrown down, and admits of being easily washed free from impurities.

Iron from Zinc.—Procure a solution of the cyanides as above, and boil the clear solution with an excess of colourless ammonic sulphide until the steam is neutral to test-papers. The zinc is wholly precipitated as sulphide quite free from iron (or nickel and cobalt if present), and in a granular condition, which may be filtered and washed with the utmost ease.

The presence of cyanates or carbonates in the potassic cyanide exerts no influence whatever on the above separations.

March 16, 1888.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending February 29th, 1888.

By WILLIAM CROOKES, F.R.S.;

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To General A. De Courcy Scott, R.A., *Water Examiner, Metropolis Water Act*, 1871.

London, March 7th, 1888.

Sir,—We submit herewith the results of our analyses of the 169 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from February 1st to February 29th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The whole of the 169 samples examined were clear, bright, and well filtered.

Even to a greater extent than during the two preceding months of December and January, the condition of the water supplied to the Metropolis during the past month has been quite exceptional for the period of the year, and was found, indeed, to fall but little short of that observable in the most favourable of the summer and early autumn months. Although the range of variation in the composition of the water of the Thames and Lea is for the most part, save after the occurrence of floods, too small to be of any practical importance, still an extent of seasonal variation, though unusually small during the present season, is commonly to be observed and calculated upon. Doubtless the exceptional condition of the water

throughout the present winter is traceable primarily to the exceptional drought, the habitual coincidence of a high character of the river-supply with the prevalence of drought being one of many general evidences showing the extensive self-purifying power of running water.

Frost also has prevailed almost continuously through the greater part of the month; but the general effect of frost is found to vary considerably, according to the circumstances under which it occurs. When succeeding a flood, it is observed, indeed, to exert a notably prejudicial effect on the process of filtration.

The mean proportion of organic carbon in the Thames-derived supply for February was fonnd to be 0·152 part in 100,000 parts of the water, as against a mean of ·158 part for January, and of 1·60 part for December. A more considerable decrease was at the same time observable in the numbers expressing the quantities of oxygen required for the oxidation of the organic matter present, and in those expressing the degree of colour-tint of the water.

We are, Sir,
Your obedient Servants,
William Crookes.
William Odling.
C. Meymott Tidy.

PROCEEDINGS OF SOCIETIES.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

Annual General Meeting, March 1st, 1888.

Address of the President, Dr. Odling, M.A., M.B., F.R.S., &c.

(Concluded from p. 119).

To revert once more to the preamble of the Charter, it is therein declared—"That the said Institute was not established for the purposes of gain, nor do the members thereof desire or seek any pecuniary profit from their membership; but the society aims at the elevation of the profession of consulting and analytical chemistry, and the promotion of the efficiency and usefulness of persons practising the same, by compelling the observance of strict rules of membership, and by setting up a high standard of scientific and practical proficiency." The Institute of Chemistry being now fairly on its way, it is in the power of the general body of Fellows to make it almost anything they please. They may, if they choose, although in despite of the spirit of the Charter, allow it to degenerate into a very inefficient sort of trades-union; or they may more wisely, as well as more rightfully, resolve upon its being so conducted as to raise it to a position of influence and reputation not inferior to that of any existing professional society. Such a result, indeed, is not to be achieved without continuous effort, and possibly even a little self-sacrifice. I do not, of course, speak merely of the pecuniary contribution, now reduced to a very modest figure, which, in order to carry on the work of the Institute, we require to exact from our members. But even with regard to this contribution, the fitting question for the contributor, I take to be, not what does he himself get in return, but in the achievement of what common good does he bear his part. Anyone who permits himself to entertain the question, "What do I get for my guinea?" must, I fear, be regarded only as an encumbrance, and a hindrance to the cause which the Institute of Chemistry was avowedly founded to aid and bring into success. To those of us who are able to look back a score of years and upwards, there are few things more noticeable than the wide-spread development of Professional Chemistry which has taken place within the last quarter of a century. It is still the case, however, though in a less degree than formerly, that certain of the more lucrative branches of professional work are, to a large extent, in the hands of a comparatively small number of persons, whose professional success has further achieved for them no little degree of personal consideration. Socially, they have been recognised as able to hold their own, in every way, with the most eminent representatives of other professions, whether of engineering, or law, or medicine, or literature, or art. That these of our colleagues have done so well for themselves is a matter of congratulation; but they have done much more than that. They have contributed to found, and obtain recognition, for the profession in which they are eminent; whereby no small gain has been achieved for the members of the profession at large. The ever-increasing demand for the services of professional chemists involves necessarily an increase in the sum-total of distributable gain; but we may now look forward also to its more widespread and equable distribution. When it becomes recognised, as it is becoming recognised, that professional chemists, whether scattered throughout the country or accumulated in particular centres, are alike members of a definite learned profession; that, in point of character, cultivation, and training, they have little or nothing to concede to one another; and that the professional guarantee of conduct and capability is the same for one as for another, it will follow necessarily that much of the work now entrusted mostly to a prominent few will be distributed among a more numerous set of persons, recognised as belonging to the same corporate body, and certified by that body to be no less capable of carrying out the work entrusted to them. It is not, however, suggested for a moment that the higher and more general estimation accorded to the status of the professional chemist, which the action of the Institute is calculated to bring about, will be altogether limited in its effects to members of the Institute. The benefit accruing from its action is not of such a kind that those who decline to associate themselves with us will find themselves wholly excluded from participation therein. But still, as the joint influence and reputation of the Institute extends, as we mean that it shall extend, they will, however competent, undoubtedly find themselves more and more heavily handicapped in the race. For however special, in particular instances, may be the work of the professional chemist, and however secluded and self-sufficing may be his habits and nature, occasions will arise in which his work, and views, and interests will come into collision with those of others; and in which the circumstance that he is not recognised by the great body of his profession as one of themselves, will be likely to tell heavily against him. On the other hand, all of us are liable at times to find ourselves in circumstances of professional difficulty and anxiety,—circumstances in which the sympathy and co-operation we are able to claim from those with whom we are associated as members of a commom professional body, is calculated to afford us no little solace; while the consideration shown to us on all hands, by reason of the professional position we are recognised to hold, may even furnish us a material support. Having regard, moreover, to the many occasions in which professional chemists have to co-operate with or oppose one another, there can be no doubt that their co-operation is rendered more hearty, and their opposition to one another more temperate and kindly, by the circumstance of their owning a common allegiance to, and taking a common interest in, the professional corporation of which they are alike members.

As regards the means by which "the elevation of the profession of consulting and analytical chemistry" may be best promoted, the particular means chiefly dwelt upon in the Charter is the requirement of evidence from all persons, hereafter desirous of entering the chemical profession by becoming successively Associates and Fellows of the Institute of Chemistry, that they have undergone a thoroughly efficient training; and that they possess both a practical and scientific knowledge of the subject of their

professional work. To what extent the requisite training can, or cannot, be satisfactorily afforded and guaranteed in private laboratories is a question on which I forbear to indicate any opinion; more especially as the matter is not one that has come under the formal notice of the Council during my tenure of office. It is likely, however, to be brought before long under the notice of the new Council; who will, I feel sure, be prepared to give it their most considerate attention, and to deal with it in a spirit of liberality, and of thoughtfulness for the best interests of the Institute and of its present and prospective members. But quite irrespectively of whatever conclusion may be come to on this vexed question, and in view of the fact of our requiring from our associates a high degree of scientific as well as of practical knowledge, we must all recognise, as a matter for congratulation, the warm interest taken in the success of the Institute, by the professors and teachers of chemistry at our different universities, colleges, and schools. We are under no small indebtedness to them for directing the attention of their classes to the advantages resulting from admission to our associateship, and for encouraging and enabling the most promising of their students to fulfil our examinational and other requirements. The strongly held opinion becoming more and more prevalent among educational bodies generally, that mere examination, however carefully conducted, does not of itself afford a satisfactory guarantee of knowledge and training, would seem to have a more especial warrant in the case of almost all subjects of practical and professional study; and is one with which the Council of the Institute is heartily in accordance. And, as regards our future Associates, indeed, it is hoped that with the co-operation of professors and teachers, means may be found of supplementing the evidence of attainment now afforded by examination, by further special evidence of training obtainable by certified records of laboratory work gone through.

Passing to another topic, the suggestion has frequently been made that, partly with a view to bringing the members of the Institute into more of personal communication with one another, and partly with a view to effecting advances in the knowledge of those branches of applied chemical science with which the professional chemist is chiefly concerned, occasional meetings of members of the Institute might advantageously be held, at which subjects of interest should be brought forward, in the form of papers or otherwise, and be considered and discussed at the meeting. There is admittedly nothing inconsistent in a professional society taking upon itself the additional functions of a scientific and publishing society; while, as to the desirability of more frequent occasions being afforded for our meeting with one another, there can, I think, be only one opinion. But the occasions, in order to be taken advantage of, must be real occasions, called forth to meet the exigencies of a real want. And it seems difficult to suggest any considerable choice of subjects within the domain of applied chemistry, which could not more fittingly be brought forward at meetings of the Chemical Society, the Society of Chemical Industry, or the Society of Public Analysts, than at any specially called meetings of our own; while an addition to the number of publications in which chemical memoirs have to be sought for, cannot, at any rate, be regarded as a wholly unquestionable good. It will be, however, for the new Council, on any representation made to them, to determine whether it would be possible, with advantage, to set aside one or two evenings a year for the consideration of specified questions of applied chemistry having a sufficiently wide professional interest to be likely to prove attractive to any large number of our Fellows,—specially concerned, as so many of them are, in their own particular departments of chemical work.

One further matter, a strictly personal one, alone is left for me to touch upon. It devolves on me now to take my presidential leave of you. Alike under the articles of the original Institute, and under the bye-laws of our now chartered corporation, the office of President of the Institute is tenable only for a period of three years in succession. As a matter of fact, it has been my privilege to occupy that position for a period of five years; and so to have had the responsibility of delivering on five occasions a more or less lengthy—I fear, sometimes, a too lengthy—presidential address; and on this point, I would venture to remark that the duty of delivering presidential addresses does not belong to the class of duties which become easier of fulfilment by dint of frequent repetition. This, my lengthened tenure of office, however, though contrary to the spirit of our regulations, has been practically unavoidable, by reason of the transitional state through which we have lately passed; and has, I need scarcely say, been strictly in accordance with special provisions made in the Charter for tiding over the period of transition. Technically, indeed, I am still eligible for yet another two years' occupancy of the presidentship. It has been very properly felt, however, that in our present state of successfully achieved position, and quietly persisting progress, there is, in respect to the office of President, no further call for any departure from established custom. It is, indeed, a subject of gratification to the retiring Council, in calling to mind their continuous, and by no means trivial, past labours, to note the steady advance of the Institute in all the material conditions of well-doing. We have been granted our Charter, and have paid all incidental expenses; we have made and obtained allowance for our bye-laws; we have largely increased our number of Fellows and Associates; we have considerably augmented our capital; and we have halved the amount of our annual subscriptions; altogether, I think, a not unsatisfactory record to look back upon.

My tenure of office, now coming to an end, must necessarily be memorable in the annals of the Institute, by reason of its embracing the period of our incorporation by Charter; and will not, I think, be without some personal memories on the part of those, at any rate, who participated in our greatly successful festival held in celebration of that event some two years ago. For myself, I can only say that if the period of my presidency has been at times an anxious and an exacting one, it has been rendered one ever to be dwelt upon as a subject of pleasing recollections, by the willing aid and kindly good will I have throughout experienced at all hands,—from my predecessors in the chair, from the Secretary and Treasurer, from the executive Councils with whom I have been associated, and from the general body of the Fellows. But the position of President of the Institute of Chemistry, however distinguished and gratifying one may feel it to be, is far from proving, or being likely to prove, a sinecure. When five years ago I most willingly, if somewhat rashly, accepted the invitation made to me to be put in nomination for the office, I confess that I somewhat under-rated the duties and responsibilities attaching thereto. I was aware of the labour and pains that had been bestowed upon the affairs of the Institute by successive Councils, and of the promising condition to which it had been brought by their efforts. I remembered the warm interest and unsparing thoughtfulness that had been expended by our first President, Dr. Frankland, not only in aiding the foundation of the Institute but in directing also the early stages of its career; nor could I be less mindful of the patient effort and ready judgment with which it was steered by my immediate predecessor, Sir Frederick Abel, through the choppy seas it had to encounter in its further progress. I knew to what a position of then present security and assured future prospects the Institute had been raised under his skilful guidance. And as it chanced that for some time before my nomination I had not served on the Council, I came to the conclusion, when thinking over the efforts and successes of my predecessors, that there was but little left for me to do; and that, following in the path their labours had marked out, I had a comparatively easy prospect before me. I fancy, however,

that the responsibilities of the position will scarcely be thought to have proved less onerous in my case than in theirs, while they have certainly been of longer duration. Indulging in a fresh self-deception with the coming on of my period of retirement, I began, I fear, to entain a sort of jealous thought in contemplating the easy burden that was likely to fall on the shoulders of my successor. But with the yet nearer and nearer approach of my retirement, I began more and more to realise that every successive year is pretty certain to make its full share of weighty demands on the time, and thought, and kindly discretion of whomsoever may fill the position of President; and I congratulate the Institute that these requirements are likely to be fulfilled in so special a degree by the distinguished chemist whom I am glad to see nominated as my successor. The desirability of having the high position of President of the Institute accorded from time to time to representatives of different branches of professional chemistry is one that all will be ready to acknowledge, and in Dr. James Bell we have the most prominent representative of a branch of applied analytical chemistry daily becoming of greater and greater importance. Of the high official position which he occupies it is unnecessary for me to speak; but I may venture to remind you of the warm interest he has ever taken in the affairs of the Institute, and of the services for which we are indebted to him. Besides taking an active part in the work of the Council and its committees, and further helping us so materially on the occasion of our conference at the International Health Exhibition, he did not fail, in the course of our applications at the Privy Council Office, to render us that personal aid which his recognised official position enabled him so effectually to afford. It is to me, as the retiring President, no small satisfaction to deliver up my office into such worthy and capable hands. For myself, I hope, though now relieved from the responsibility of the Presidency, to be still of some service to the Institute, by taking part from time to time in the more important deliberations of the Council. And I can only regret that the circumstance of my living at a distance from London will, as it must, preclude the possibility of my affording to Dr. Bell that extent of ever-ready co-operation and counsel which has been so continually extended to me by my distinguished predecessors, Dr. Frankland and Sir Frederick Abel, and, I would add, by my colleague, Mr. Carteighe, the much-esteemed President of the Pharmaceutical Society. To these, as indeed to all of my friends on the successive Councils, by whom, during my long period of office, it has been my good fortune to be so loyally supported, I have, in now bidding them good-bye, to tender the expression of my warmest thanks.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, March 5, 1888.

Edward Woods, Esq., M.Inst C.E. and Vice-President, in the Chair.

The following were elected Members:—Frederick Beer, Thomas Buckney, F.R.A.S., the Hon. Justice Day, J. E. Drower, George Beloc Ellis, David Charles Guthrie, Robert George Hobbes, Graham Hutchison, J.P., Mrs. William Moir, Percival Arthur L. Pryor, Vincent Joseph Robinson, Alfred Richard Sennett, Louis Sterne, George Philip Willoughby.

Seven Candidates for Membership were proposed for election.

The special thanks of the members were returned for following donation to the fund for the promotion of experimental research:—Professor Dewar, £100.

The presents received since the last meeting were laid on the table, and the thanks of the members returned for the same.

NOTICES OF BOOKS.

Practical Education, treating of the Development of Memory, the increasing Quickness of Perception, and Training the Constructive Faculty. By Charles G. Leland. London: Whittaker and Co.

In this work, whilst there is much which strikes us as excellent and as worth putting in practice, there is also much about which we cannot feel other than doubtful. Some of these difficulties may be smoothed away by remembering that, whilst we instinctively look upon intellectual education as a training for the task of discovery, the author is aiming at industrial art-work. This difference naturally leads him to assign different relative values to the culture of different faculties of the mind. He begins in his schools by teaching design,—no bad initial step in any case. He rightly rejects the possibility of teaching "trades" to children, but he holds that even very young children can "profitably and pleasantly master the decorative arts." He aptly remarks that "As the flower precedes the fruit, decorative art is developed in a race before it attains proficiency in practical work. Long before men had good axes, knives, or any kind of decent tools, they made jewellery and embroidery superior in design or character to anything produced in modern times." It seems, then, that if the modern child is an abridged reissue of the pristine races of mankind, our modern educational systems, instead of developing, extinguish him, by plunging him into words when he craves to deal with things. This verbalism is the great foe both to art and to science.

The author says that "the average *savage* is not, as regards innate artistic capacity or *intellect*, superior to an English schoolboy." But the schoolboys' innate powers of observation have been crowded out by the the three R's or by the classics.

The following remark needs thundering into the ears of reformers, social and political:—"It is one of the great causes of poverty and suffering in the world that the so-called practical men reject with scorn all branches of industry which are not regular and 'staple.'" "The entire population of Ireland might be employed in the minor arts without glutting the market." And again:—"The great reason why Germany is taking the lead in the world's markets is because she teaches art to her apprentices."

In a succeeding chapter we find protests, more or less explicit, against the *verbalism* of our education:—"The small tailor sends his sons to colleges, where they learn words and nothing more." Again:—"Truly the boast of the great men who have graduated of old from certain American—and we may add English—colleges sounds like a Brinvilliers or a Borgia pointing to her escaped victims as a proof of her humanity."

But who would expect after noting these passages, and indeed after carefully reading the entire "Part First" of this book, that Mr. Leland would consecrate his "Part Second" to "developing memory," and, as it further appears, verbal memory? It is the conviction of most men who consider the subject that the great fault of our present—and still more of our past—educational system is that it has resolved itself too much into the development of verbal memory. Such must, indeed, of necessity be the characteristic of every education which busies itself with words rather than with things. Says the author:—"I have been intimate with a learned Chinese who had passed the great examination of Pekin, and I am confident that, though quite a young man, his memory contained ten times as much as any European I ever met." But "as much" of what? Could this learned Chinese effect any addition to the sum total of human knowledge? And if not, we must pronounce that he had been, like so many examinees, simply wasting his time.

Again we come upon a passage simply reprehensible:—

—"What we read of the scholastic disputations of the Middle Ages, and what we observe of the colossal erudition then current, has often drawn forth the remark that there were giants in the land in those days." But would any of these "giants," or would all of them together, be equal to a tenth part of a Newton, a Darwin, a Liebig, a Lavoisier, or a Faraday? What we have to cultivate is not its power of assimilating, but of originating. In short, we submit that this Part on the development of memory would better have been omitted.

Part III., on "Creating Quickness of Perception," is of much greater importance, though the author seems disposed to lay too much weight upon nurture and too little upon inherited nature. But we do not think that mere "quickness of perception" is a capital point. The first condition in observation is accuracy; that the observer should take in every feature of an object presented to him, overlooking nothing, over- or under-estimating nothing, distorting nothing, and, above all things, not superadding to the phenomena his own conclusions or imaginings. The speed at which this is effected is but a subsidiary matter.

It is with real pain that we see so judicious an author attempting, in opposition to the late Sir Arthur Helps, to defend competitive examination. He forgets that no examination can test a man's power of origination, his mental fertility, and the scope of his resources. Nay, as the man highly endowed in these respects often "crams" badly, he is apt to be rejected in favour of the one whose sole faculties are memory and quickness, and who has readily assimilated the work of others.

We are glad to find, however, that in a subsequent chapter he shows himself fully alive to "the absurdity of endeavouring to stimulate study by competition." To base work or study on the principle of competition is, he urges, "even more injurious than the insane idea of making it amusing."

This work, in spite of certain defects which we have felt it our duty to point out, is as a whole strongly to be recommended.

Report on Indian Fibres and Fibrous Substances exhibited at the Colonial and Indian Exhibition, 1886. By C. F. Cross, E. J. Bevan, and C. M. King, in association with E. Joynson. With Notes on Methods of Treatment and Uses prevalent in India, by Dr. G. Watt, C.I.E., M.B., C.M. Published by authority of the Secretary of State for India. London and New York: E. and F. N. Spon.

The present volume chiefly embodies the results of a laboratory investigation of the vegetable fibres displayed in the Indian Section of the Colonial Exhibition. At a Conference held on June 16th, 1886, Mr. Cross offered to make scientific and practical experiments on the entire series of fibres in the Indian Courts, if samples were supplied, and if the Government of India would undertake to publish the results.

The primary object of the authors was purely scientific, viz., to test on the widest range of substances the methods adopted on the examination of vegetable fibres, and, secondly, to classify the fibres according to the results, if found satisfactory. Along with these scientific aims was the quest for practical results. They point out as something remarkable the fewness of the available fibres actually employed in European manufactures, and raise the question whether this restricted application of raw materials lies in their inherent properties or in the mere incidents of distribution and commerce. Their method of examination depended on the joint application of chemical and microscopical procedures. The operations resorted to consisted in the determination of moisture and of ash in the ordinary manner, hydrolysis under the influence of dilute boiling alkalies, examination of the cellulose, mercerising, nitration, combustion, and acid purification. The minute structure of the fibres is shown in an accompanying series of micro-photographs. Applicability of fibres in the textile arts depends, first, on their fineness; secondly, by the length and diameter of the "spinning unit"; and thirdly, on the length of the ultimate fibre cell.

There are over 300 fibre-yielding plants in India, one-third of which are regularly used by the natives, and perhaps thirty are worth recognition in Britain.

The exports of Indian manufactured goods improved during the year by nearly £1,000,000; jute remained stationary, and the exports of raw silk and wool fell off. British yarns would be more largely consumed in India were it not for the obstinacy shown by our manufacturers in refusing to imitate native qualities. This same obstinacy, as compared with the more accommodating spirit shown by German, French, and American industrialists, militates against British trade in many countries and in many articles.

It is of course impossible for us to follow the authors in their examination of the many fibres which have passed under their examination. An important fact noticed is the correlation of lignification with shortness of ultimate fibre. The authors know of no bast fibre having the characteristic in which the length exceeds 5 m.m. They reject, as not in harmony with facts, the common theory of lignification, "in so far as it accounts for the particular chemical composition of lignified fibre as an overlaying of a pure cellulose with encrusting substances of different composition." They rather conclude that the ligno-celluloses are primary plant constituents in the same sense as the celluloses. They would be glad to see more attention paid, from a technical point of view, to the celluloses isolated from *Calotropis* and *Mardenia*. In the jute class *Sida rhombifolia* is the most deserving of notice, and among the Monocotyledons they place the pine-apple fibre highest.

The Rothamsted Experiments on the Growth of Wheat, Barley, and the Mixed Herbage of Grass Land. By William Fream, B.Sc., F.L.S., &c., Professor of Natural History in the College of Agriculture, Downton, Salisbury. 8vo., 235 pages. London: Horace Cox, *The Field* Office, 346, Strand, W.C.

In the excellent little volume before us we have incorporated, in a convenient, concise, and lucid form, the subject-matter, inferences, and opinions contained in the very extensive and valuable reports relating to the experiments on the growth of wheat, barley, and grass, which have emanated from the universally celebrated experimental station at Rothamsted. The fact that it treats of the work of Lawes and Gilbert will be sufficient to commend it to all agricultural chemists; but this book will be hailed with great pleasure by a still larger section of chemists in search of truths in agricultural chemistry, who cannot spare the time required for the adequate perusal of the numerous voluminous and elaborate original memoirs of these authors, which cover many hundreds of pages, and which are, moreover, in many cases practically inaccessible.

Briefly speaking, the volume treats of the effect exerted on the quantity and quality of the produce and on the soil: —1. By cultivating crops of wheat, barley, and grass without manure, with mixed mineral manure, with ammonia salts, with sodium nitrate, with farmyard and some other organic manures, either alone or mixed together, and in varying proportions. 2. By the character of the season and climatic influences during cultivation. In addition there are chapters on unexhausted manurial residues, on crop statistics, and on botanical points. All these matters are admirably discussed and illustrated, and, being in one volume, the statements can be compared with one another with the greatest facility, more especially as there is a useful index and table of contents, whilst the headings of sections are printed in prominent type.

Turning our attention to some of the points raised and

discussed we are struck by the all-importance of nitrogen, without which no manure produces any appreciable effect on crops of wheat, barley, or grass; by the slow action of this element when in organic combination (as in farmyard manure, rape cake, &c.), therefore large dressings of nitrogen in the form of farmyard manure are required in practice; and by the great potency of ammonia salts and nitrates. But we notice that even this useful element, applied either in excess or when cinereal constituents of the plants are deficient in the soil, gives rise to large but immature crops, since without the supply of food material is complete in all respects plants will not mature properly. Five lbs. of ammonia salts under average conditions will produce an increase of 1 bushel of wheat, whilst a similar increase in a barley crop is obtained by manuring with 2 to 2¼ lbs. of ammonia. It is estimated that only 5 per cent of a wheat crop is derived from the soil, the remainder coming from the air. The strength and stiffness of straw does not depend on a large percentage of silica, but is due to the favourable development of the woody substance. Very interesting are the results obtained by manuring grass land; the remarkable changes in the character of the herbage, and the strange effects on their development, are tersely and vividly set before the reader.

The chapters on the fate of nitrogen and other manure constituents in the soil are of great interest: we see, for instance, in crops of hay manured with farmyard manure equivalent to 1606 lbs. of nitrogen per acre for eight years, only 291 lbs. of this nitrogen is recovered in increase of crop during twenty years; that after that period the soil, to a depth of 27 inches, contains 911 lbs., or 56·7 per cent, of this residual nitrogen, leaving 25·2 per cent unaccounted for and lost: many other similar instances of loss of nitrogen are given.

With regard to other manure constituents the following proportions per cent of the quantity applied in manure reappeared as increase of crop during twenty years or so:—Lime 6 per cent, magnesia 21 per cent, potash 48 per cent, phosphoric acid 33 per cent, silica 22 per cent, and so on. Of the most important, the potash and phosphoric acid, it is observed that they are very little subject to loss by drainage, but the unrecovered residues appear to become "so locked up (or distributed) as to be but slowly available to succeeding crops."

We cannot quite agree with the statement "that there are few really large sources of nitrogenous manures which do not, at the same time, bring upon the land a considerable amount of some of the more important minerals also." We should like to have seen some reference to the milling and food value of wheat grown by different manures; to the malting value of barley from the different plots; and also more about the feeding value of the hay—the only information we find on this point is on pages 166 and 172.

We have not observed any reference to the wheat crops crops obtained in the four-course rotation, or in the experiment where wheat is grown alternately with fallow.

A very useful feature of this book is the numerous Tables, with their accompanying remarks. We think a small Table showing the amount of ammonia required, under various manurial circumstances, to produce an increase of 1 bushel per acre in the barley crop (similar, for instance, to the one given on page 54 for the wheat crop), would have been useful.

This volume we are sure will be found extremely interesting to all who take any interest in the scientific diagnosis of natural phenomena; for here we have the results of half a century's accurate experiment, in one of the most complicated of Nature's operations, set before us in a masterly and clear manner which reflects great credit to the patience, zeal, and astuteness of the author.

The eminent investigators whose labours form the subject-matter of this volume show their appreciation of Prof. Fream's exertions by accepting the dedication of the book.

CORRESPONDENCE.

IS A SAFE A SAFE NOW?

To the Editor of the Chemical News.

Sir,—The notice which appeared under this heading (Chemical News, vol. lvii., p. 121) must strike anyone having charge of the custody of valuables with serious alarm.

One simple and certain remedy is to cover the sides and door of the strong room or safe with a network of insulated wires, which would fuse at a much lower temperature than iron or steel, by which an electrical circuit would be broken and a powerful gong set ringing. Of course the battery or other arrangement should be enclosed in the safe, as well as the gong.

The wires may be as close together as we please; and to prevent the possibility of the fused ends falling on the metal floor of the safe, which would restore metallic contact, a not easily fusible insulator should be employed, or a substance like sulphur may be used, which would insulate by forming a metallic sulphite. Vulcanised rubber over a well-tinned copper-wire, or iron or lead, would be suitable. Fusible alloys have been used for conductors for thief-detectors, fire-alarms, &c., but I believe only experimentally.

Experiments should be made at once in this direction, so as to be prepared for the scientific onslaught on our valuables.

Unfortunately it is that comfortable assurance in security which we indulge in that arms the burglar and scientific thief. It is easily possible that no window or door in a house can be opened without raising an alarm, but, when these arrangements are fitted up, the alarm in a short time becomes a nuisance. The burglar knows this, and reckons on the chance.—I am, &c.

Thomas T. P. Bruce Warren.

Tamworth Villa, Earlham Grove,
Forest Gate.

FAT EXTRACTION APPARATUS.

To the Editor of the Chemical News.

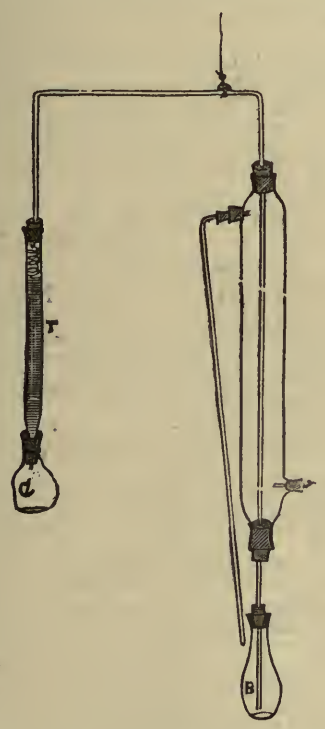
On perusing the description of Mr. Barlow's device and the letter of Dr. Knecht (Chemical News, vol. lvii., pp. 56 and 91), it occurs to me that the apparatus I have used for some time, in preference to Soxhlet's and all others may have some interest for your readers, and I shall be glad if you can afford space for this letter in an early issue.

The contrivance of Mr. Barlow is undoubtedly ingenious, but it seems to me that, besides possessing the failings pointed out by Dr. Knecht, it would be likely to prove a troublesome piece of apparatus to use and to keep in working order. It would, for instance, be a difficult matter to fit and perforate the two corks, C and S, so that the tubes D and V could be manipulated as required without being loose and leaky, or soon becoming so. The general want of neatness and rigidity of the apparatus, and the trouble entailed in working it, are certainly disadvantages of no small account. As an elegant piece of workmanship, combining the maximum extractive effect with the minimum trouble in manipulation, Soxhlet's is the best that I know for samples sufficiently granular to give the solvent free passage. But I have frequently been unable to use it for extracting finely ground materials, in consequence of its admitting of no pressure being applied to the surface of the liquid while being drawn through.

The apparatus I constructed for myself some years ago, and have since used exclusively without accident or trouble, is a modification of Church's apparatus, the essential improvement being in the removal of the danger

of bursting the flasks, or driving out the corks, by pressure during the distillation. The extraction of a sample occupies no more than an hour as a rule, while the recovery of the ether is accomplished, and loss by evaporation is avoided, just as effectively as with any other apparatus.

The tube T—a piece of ordinary combustion tube, drawn out to go through the cork of flask *a*—contains the substance, which is kept in its place by a plug of cotton pushed pretty tightly into the lower end of tube, and, by a more loosely-fitted plug above, held down by a spiral string of common wire. The tared flask *a* is short and wide, with a capacity of 80 to 90 c.c., and is heated in the usual way by a beaker of hot water. Flask B has a similar capacity to *a*, but is preferably of a taller form, and is inserted in a beaker of cold water kept overflowing by a continuous stream from the tap, passing first through the condenser. The tube leading from T to the bottom of flask B is ¼ inch internal diameter, and has no joining. The cork of B has a small V notch opening to the air, to prevent either pressure or rarefaction in the



apparatus as the process proceeds. The whole is suspended by a string attached to any convenient fixture, and can thus be adjusted to make the flasks hang at a suitable height in the beakers. When an extraction is being commenced, 2 or 3 c.c. of ether is put into flask *a*, B is half filled with the same liquid, and the corks are all firmly inserted. The apparatus is now lowered to its normal position, when the ether in *a* is vaporised, expelling the air. The apparatus is now lifted bodily (by taking hold of the condenser), and flask *a* is plunged into a beaker of cold water standing beside the hot one. In a few seconds the liquid ether in B is completely drawn into *a*, carrying along a portion of the oil in the sample. Flask *a* is again inserted in the hot beaker, when distillation commences, and is allowed to continue until the greater portion of the ether be condensed in B: *a* is again dipped in the cold water, and the operation is repeated until the sample be completely extracted.

I find it convenient to use two hot-water beakers, one standing over an argand and ready to replace the other at each new distillation.—I am, &c.,

A. A. Lumsden.

Forth Chemical Works,
Boness, March 15, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 10, March 5, 1888.

Transformation of Nitrates into Nitrogenous Organic Compounds in the Soil. — M. Berthelot. — The author infers from his researches that the assimilation of the nitrogen of nitrates by plants is accompanied, if not preceded, by their transformation into nitrogenised organic compounds in the soil under the influence of chemical reactions and of special microbia. These latter are possibly the same which fix the free nitrogen of the atmosphere in a soil where nitrates are absent. Only if we supply combined nitrogen which is more easily assimilable they take it in preference. In any case two orders of action, distinct if not antagonistic, compete in the vegetable mould. On the one hand the microbia of nitrification tend to convert the ammoniacal salts and the nitrogenous organic matters of the soil into nitrates. Other chemical reactions and other nitrates operate in an inverse direction, reducing these nitrates to the state of nitrogenous organic compounds.

Saccharomyces ellipsoideus and its Applications in the Production of a Wine from Malt. —George Jacquemin.—The author proves experimentally that the elliptical ferment of wine is a stable permanent species, distinct from the ferment of beer. If the former is added to a decoction of malt to which 2·5 per cent of potassium bitartrate has been added (to prevent the invasion of the lactic ferment) the product of the fermentation is a true wine.

Electric Conductivity of Concentrated Nitric Acid. —E. Bouty.—The author considers that all the states of dilution of nitric acid do not contain one and the same electrolyte. Solutions containing from 1 to 4 mols. of water give off at the negative pole hyponitric acid; from this point to that of maximum conductivity there is given off a mixture of gases of which nitrous acid is an element. Solutions from that point to the most extreme dilution give off merely hydrogen.

On Cinchoniline.— MM. Jungfleisch and Léger. — Cinchoniline is an isomer of cinchonine, forming splendid crystals. It is very sparingly soluble in water, freely soluble in ethylic and methylic alcohols, chloroform, benzene, ether, and acetone. It is decomposed by heat, yielding the same products as cinchonine. It reduces potassium permanganate in the cold. It forms basic salts and neutral salts having an acid reaction.

Oxidation-Products of the Hydrazo-camphenes.— C. Tanret. — The author obtains azo-camphene, $C_{80}H_{64}N_4O_{16}$. This compound is obtained in two mutually convertible modifications called, from their colour, cyan-azo-camphene and leuk-azo-camphene.

On Terpinol, an Artificial Reproduction of Eucalyptol or Terpane.—MM. Bouchardat and Voiry.—The terpinol of List is a mixture of inactive crystalline terpilenol or terpol, $C_{20}H_{18}O_2$, boiling at 218°; of terpane, $C_{20}H_{18}O_2$, boiling at 175° and crystallising at −1°, and of inactive terpilene, $C_{20}H_{10}$.

Preparation of Bibasic Glycerinates.—M. de Forcrand.—If 1 mol. of sodium ethylate is caused to act upon 1 mol. of monobasic sodium glyceronate the ex-

change of sodium does not take place below 180°, and is accompanied by secondary decompositions indicating a profound decomposition of the glycerin molecule.

Bulletin de la Société Chimique de Paris.
Vol. xlviii., Nos. 4 and 5, Sept. 5, 1887.

The Constitution and Synthesis of Pilocarpine.—E. Hardy and Gaetan Calmels.—In this lengthy paper the authors describe pilocarpic acid, a new base, pilocarpidine, jaborine, jaboric acid, the products obtained by splitting up jaborine, and its synthesis setting out from β pyridin-α-lactic acid.

The Chemical Function of Inosite.—M. Lorin.—The author shows that he demonstrated ten years ago the chemical function of inosite as a polyatomic alcohol.

Certain Substances produced by the Action of Hydrochloric Acid Gas upon Glycerin.—MM. Fauconnier and Sanson.—The principal product is a polymer of epichlorhydrine.

Oxidation-Products of the Black Azulmic Matter obtained by the Electrolysis, in an Ammoniacal Solution, of Purified Gas Coke.—A. Millot.—The products obtained are ammelide, cyanuric acid, and ammonium sulphate.

Certain Novel Permanganates.—T. Klobb.—The compounds described are the luteo-cobaltic permanganate, the corresponding chloro-permanganate and bromo-permanganate, and the compound of potassium chloride with the luteo-cobaltic chloride and permanganate.

Practical Analysis of Gases, with Especial Reference to Carbon Dioxide, Carbon Monoxide, and Oxygen.—J. Sinibaldi.—This memoir requires the accompanying figure.

MISCELLANEOUS.

Royal Institution.—The following are the Lecture Arrangements after Easter:—Dr. Charles Waldstein, Three Lectures on John Ruskin; Mr. Walter Gardiner, Three Lectures on The Plant in the War of Nature; Mr. Sidney Colvin, Three Lectures on Conventions and Conventionality in Art; Prof. Dewar, Six Lectures on The Chemical Arts; Prof. T. G. Bonney, Three Lectures on The Growth and Sculpture of the Alps; Mr. Carl Armbruster, Seven Lectures on The Later Works of Richard Wagner (with Vocal and Instrumental Illustrations); Prof. C. E. Turner, Three Lectures on Count Tolstoi as Novelist and Thinker. The following are the probable arrangements for the Friday Evening Meetings after Easter:—Prof. Flower, The Pygmy Races of Men; The Right Hon. Sir William R. Grove, Antagonism; Mr. James Wimshurst, Electrical Influence Machines; Prof. J. K. Laughton, The Invincible Armada: a Tercentenary Retrospect; Mr. W. H. Barlow, Building the New Tay Bridge; Mr. Francis Galton, Personal Identification and Description; Prof. J. A. Ewing, Earthquakes and how to measure them; and a Discourse by Prof. Dewar.

Hofmann Testimonial Fund.—A sum of £255 has been subscribed in this country by the past pupils, friends, and colleagues of Dr. A. W. Hofmann, as an offering to the general fund now being raised in Europe and America as a Testimonial to the Professor on attaining his 70th birthday anniversary, on the 8th of April next. To mark the occasion a Bust has already been executed, which, together with a suitable form of Address and the collected funds, will be presented by a deputation of the German Committee. Subject to approval, it is proposed to devote the available money-balance to the founding of an International Scholarship, which should bear the name of the eminent Professor, who for more than forty years has laboured so successfully, in England and Germany, for the promotion of Chemical Science and the training of his numerous pupils. The British Committee, of which Sir Frederick Abel is Chairman, will gladly receive any additional contributions from those sympathising with the movement, whom it has been found impossible to reach by printed circular. As the date of presentation is so close at hand, intending donors are requested to communicate immediately with—

C. E. Groves, F.R.S., Treasurer, Kennington Green, SE.;

Or John Spiller, F.C.S., Hon. Sec., 2, St. Mary's Road, Canonbury, N.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Earrings.—Is it safe to wear zinc or nickel, commonly called German silver, as earrings? What are the chemical properties contained in these metals?—Maria Tibus.

MEETINGS FOR THE WEEK.

Monday, April 2nd.—Royal Institution, 5. General Monthly Meeting.
Tuesday, 3rd.—Pathological, 8.30.
Thursday, 5th.—Chemical, 8. "Researches on the Constitution of Azo- and Diazo-derivatives. Part III. Compounds of the Naphthaline β-Series." By Prof. R. Meldola, F.R.S., and F. J. East.
Friday, 6th.—Geologists' Association, 8.

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AN EPITOME OF
THE LAW AND PRACTICE
CONNECTED WITH
PATENTS FOR INVENTIONS.
With a Reprint of the Patents Acts of 1883, 1885, and 1886, and Rule and a Summary of the Patent Laws of Foreign Countries and British Colonies.
By JAMES JOHNSON, Barrister-at-Law, and J. HENRY JOHNSON, Assoc. Inst. C.E., Solicitor and Patent Agent, Authors of "The Patentee's Manual."
London: LONGMANS, GREEN, and CO., Paternoster Row.

ST. PAUL'S SCHOOL.—An Examination for filling up about Four Vacancies on the Foundation will be held on the 11th of April, 1888, and following days.—For information apply to Mr. S. Bewsher, Bursar, St. Paul's School, West Kensington.

LONDON HOSPITAL and MEDICAL COLLEGE, MILE END, E.
The SUMMER SESSION will COMMENCE on TUESDAY, May 1st.
The new College Buildings are now complete, and afford more than double the former accommodation.
Students now entering are eligible for the entrance Scholarships in September.
The Hospital contains nearly 800 beds, and is the largest General Hospital in Great Britain.
General fee for Lectures and Hospital practice, 90 guineas in one sum, or 100 guineas in three instalments. The Resident and other Hospital Appointments are free to full Students.
Special entries may be made for Medical and Surgical Practice, also for the course of Practical Surgery.
The London Hospital is now in direct communication, by rail and tram, with all parts of the Metropolis, and the Metropolitan, Metropolitan District, South-Eastern, and East London Railways have stations within a minute's walk of the Hospital and College.
For prospectus and particulars apply to
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Sale of the MARSH CHEMICAL WORKS, LLANSAMLET, SWANSEA,
near the Junction Station of the Great Western and Midland Railways, from which a siding runs to the Works.
The property consists of Two Lead Sulphuric Acid Chambers, about 75,000 cubic feet capacity, each Chamber 120 ft. by 24 by 13 ft., adapted for the making of Sulphuric Acid from Pyrites, Spent Oxide, and Sulphur. There are also Salt Decomposing Pot and Condensers for making Muriatic Acid. Workmen's Shops, extensive Tile-covered Sheds, and covered Areas, Buildings, and Office. Stack, 100 feet. Area of land, 5 acres. Rent, £37 10s.
The whole is built at an elevation of 20 feet, thus giving ample space and depth for waste.
For Particulars and Conditions of Sale address Mr. J. E. STEVENS, Solicitor, Swansea.

THE CHEMICAL NEWS.

Vol. LVII. No. 1480.

ON CERTAIN MECHANICAL PROPERTIES OF METALS, CONSIDERED IN RELATION TO MENDELEEFF'S LAW.*

By W. CHANDLER ROBERTS-AUSTEN, F.R.S.,
Professor of Metallurgy, Normal School of Science, South Kensington.

The author points to the great industrial importance of the influence exerted by small quantities of metallic and other impurities on masses of metals in which they are hidden. He states that this is most marked in the case of iron, and that when Bergman discovered, in 1781, that the difference between wrought iron, steel, and cast-iron depends on the presence or absence of a small amount of "graphite," he was astonished at the smallness of the amount of matter which is capable of producing such singular changes in the properties of iron. The evidence as to the importance of small quantities of impurity is quite as strong in other directions at the present day, as is shown by the statement of Sir Hussey Vivian, that one-thousandth part of antimony converts "best select" copper into the worst conceivable, and by the assertion of Mr. Preece, that "a submarine cable made of the copper of to-day," now that the necessity for employing pure copper is recognised, "will carry double the number of messages that a similar cable of copper would in 1858," when the influence of impurities in increasing the electrical resistance of copper was not understood.

Allusion is made to the effect of a small quantity of tellurium on bismuth. Commercially pure bismuth has a fracture showing brilliant mirror-like planes, but if the one-thousandth part of tellurium be present the fracture is minutely crystalline. Specimens of bismuth are submitted to the Society. The author states that in his own experiments he has employed gold prepared by himself with great care, the purity of which has been recognised by no less an authority than M. Stas. A portion of this gold was recently used by Professor Thorpe in a determination of the atomic weight of gold. Gold was selected for the experiments for the following reasons:—It can be prepared of a very high degree of purity; it possesses considerable tenacity and ductility; the accuracy of the results of the experiments is not likely to be disturbed by the oxidation of the metal or by the presence of occluded gases; and the amount of impurity added to the gold can be determined with rigorous accuracy. The influence of small quantities of metallic impurity in rendering gold brittle has long been known, and is frequently referred to by the older metallurgists, especially by Geber, Biringuccio, and Gellert, and by Robert Boyle. The first systematic experiments on the subject were made by Hatchett at the request of the Privy Council, and were communicated to the Royal Society in 1803. Hatchett concluded that certain metals, even when present in so small an amount as the $\frac{1}{1000}$ part of the mass, will render gold brittle, and he stated that "The different metallic substances which have been employed in these experiments appear to affect gold in the following decreasing order:—1. Bismuth; 2. Lead; 3. Antimony; 4. Arsenic; 5. Zinc; 6. Cobalt; 7. Manganese; 8. Nickel; 9. Tin; 10. Iron; 11. Platinum; 12. Copper; 13. Silver." Mr. Hatchett did not, however, employ pure gold, and in his time the importance of submitting metals to mechanical tests was not understood.

* Abstract o a Paper read before the Royal Society, March 15th, 1888.

The author then proceeds to describe the results of his own experiments, and he states that in selecting tenacity as the test to which the metal should be submitted with a view to ascertain the effect of the added matter, the following considerations presented themselves. W. Spring has built up alloys by compressing the powders of the constituent metals, and by pointing to the evidence of molecular mobility in *solid* alloys, he has done much to show the close connexion which exists between cohesion and chemical affinity. Raoul Pictet considers that there is intimate relation between the points of metals and the lengths of their molecular oscillations, the length of the oscillation diminishing as the melting point increases; and, as Carnelley has pointed out, "We should expect that those metals which have the highest melting points would also be the most tenacious." It is known that the melting points of metals are altered by the presence of small quantities of foreign matter, and their cohesion is also thereby altered. The degree of cohesion may thus be investigated either by the aid of heat or by mechanical stress. It might have been well to ascertain the amount of change in the melting point of gold produced by the presence of the different elements in small quantity, but, unfortunately, slight variations in high melting points are very difficult to determine with even approximate accuracy, and it appeared to be better to ascertain the effect of metallic and other impurities on the cohesion of the gold, as indicated by the amount of force externally applied in an ordinary testing-machine, and in that way to ascertain whether the effect of added metals is amenable to any known law.

The purest gold attainable has a tenacity of 7·0 tons per square inch, and an elongation of 30·8 per cent on 3 inches. Professor Kennedy found that a less pure sample which contained 999·87 parts of gold in 1000, broke with a load of 6·29 tons per square inch; it had an elastic limit of 2·12 tons per square inch, and elongated 18·5 per cent before breaking. In the following experiments only the purest gold that could be prepared was employed. The effect on the tenacity of gold produced by adding to it about 0·2 per cent of various metals and metalloids is shown in the following table, in which the results are arranged according to the tensile strengths:—

Name of element added.	Tensile strength of test-piece. (Tons per sq. in.)	Elongation. Per cent (on 3 inches).	Impurity. Per cent.	Atomic volume of impurity.
Potassium ..	Less than 0·5	Not perceptible.	Less than 0·2	45·1
Bismuth ..	0·5 (about)	,,	0·210	20·9
Tellurium ..	3·88	,,	0·186	20·5
Lead	4·17	4·9	0·240	18·0
Thallium ..	6·21	8·6	0·193	17·2
Tin.	6·21	12·3	0·196	16·2
Antimony* ..	6·0 (about)	?	0·203	17·9
Cadmium ..	6·88	44·0	0·202	12·9
Silver	7·10	33·3	0·200	10·1
Palladium ..	7·10	32·6	0·205	9·4
Zinc	7·54	28·4	0·205	9·1
Rhodium ..	7·76	25·0	0·21 (about)	8·4
Manganese..	7·99	29·7	0·207	6·8
Indium*. ..	7·99	26·5	0·290	12·1
Copper.. ..	8·22	43·5	0·193	7·0
Lithium* ..	8·87	21·0	0·201	11·8
Aluminium*.	8·87	25·5	0·186	10·1

Reasons are given for adding the comparatively large amounts of impurity (two-tenths per cent), notwithstanding that even "traces" of certain metals would have produced very marked effects upon gold, and evidence is adduced to show that exact concordance in the respective amounts of matter added to the gold is not of much importance.

The testing-machine is of the form devised by Professor Gollner, and used by him at Prague. It is a double lever vertical machine working up to a stress of 20 tons.

The author points out that these results lead to the

conclusion that the tenacity of gold is affected by the elements in the order of their atomic volumes, and he discusses the evidence in favour of this view at some length, pointing especially to the fact that while those elements, the atomic volumes of which are higher than that of gold, greatly diminish its tenacity, silver, which has nearly the same atomic volume as gold, hardly affects either its tenacity or its extensibility. He shows that so far as the experiments have been conducted, not a single metal or metalloid which occupies a position at the base of either of the loops of Lothar Meyer's curve (which is a graphical representation of the periodic law) diminishes the tenacity of gold, while, on the other hand, metals which render gold fragile all occupy higher positions on Meyer's curve than gold does, and he urges that the relations between these small quantities of the elements and the masses of metal in which they are hidden are under the control of Mendeleeff's law of periodicity, which, as originally expressed, states that "The properties of the elements are a periodic function of their atomic weights." Carnelley has given strong evidence in favour of supplementing the law as follows:—"The properties of *compounds* of the elements are a periodic function of the atomic weights of their constituent elements," and the question arises, "May the law be so extended as to govern the relations between the constituent metals of alloys in which, as is well known, the atomic properties are often far from simple?"

The effect on gold of small but varying quantities of metals, singly and in presence of other metals, demands examination, and their influence on the specific gravity of gold must be ascertained. Until this has been done no explanation as to the mode of action of elements with large atomic volumes will be attempted.

ON THE

DETERMINATION OF THE AMOUNT OF MORPHIA PRESENT IN OPIUM.

By ROWLAND WILLIAMS, F.C.S., F.I.C.

Having had considerable experience in the examination of opium for the percentage of morphia, I have read with much interest the paper bearing the above title by E. F. Teschemacher and J. Denham Smith, which recently appeared in the Chemical News (vol lviii., pp. 93 and 103).

About two years ago two Persians came to work in my Laboratory, with the object of ascertaining the most reliable method for estimating morphia in opium. When in their own country these gentlemen are engaged in the opium trade, and wished to be able to guarantee the amount of morphia in each consignment before shipment, so as to avoid disputes and allowances as far as possible. My Persian pupils stayed with me about six months, during which period we examined a large number of samples of opium and investigated some of the most promising processes I could find in various works which I consulted on the subject. A short account of a few of our results may perhaps be of interest to some of your readers.

At first we worked almost entirely by the *British Pharmacopœia* process, and our experience was very similar to that of Teschemacher and Smith, viz., fairly concordant amounts of morphia could be obtained from duplicate estimations, but the morphia was by no means pure. We always employed a carefully graduated cylinder, marked at 1040 fluid grains, for measuring the aliquot portion of 1400 fluid grains, as "a wide-mouthed 6-ounce bottle" is obviously quite unfit for such a purpose. In other respects we followed the directions as closely as possible. We were in the same predicament as Messrs. Teschemacher and Smith with regard to taking 1040 grains of the filtrate, as there seems no clear reason why this quantity should be regarded as equivalent to 100 grains of the opium; nevertheless 1040 grains were always used in our estimations. We made two or three dozen determinations of morphia by the B.P. process, but finally abandoned it altogether, as we had already gained sufficient experience to warrant our coming to the conclusion that any method in which lime is employed is, for many reasons, unsuitable for the estimation of morphia in opium.

We next turned our attention to Flückiger's method. Several samples were examined by this method, and it must be admitted that it generally yields very clean white crystals, being in this respect a decided improvement on the B.P. process. This is, no doubt, partly due to the preliminary digestion of the dried opium with ether, which is said to remove narcotin, wax, and colouring-matter, and partly owing to the non-employment of lime, which, I believe, generally produces a dark-coloured morphia. Afterwards we tried the United States Official method, which is in many respects very similar to the B.P. process, and in our hands yielded almost the same results.

In the following Table are given results obtained from four samples when examined by the different methods:—

	Morphia per cent.		
	British.	German.	American.
Sample No. 1 ..	10·8	10·2	11·1
" No. 2 ..	10·5	10·0	10·8
" No. 3 ..	7·4	7·1	8·1
" No. 4 ..	12·2	10·6	11·9

A glance at these figures will show that in every case the German method gave the lowest result, and the American the highest except in Sample No. 4.

Our work in connection with these three processes had by this time convinced me that it was undesirable to take aliquot portions of filtrates, as this mode of operating is undoubtedly liable to cause serious errors. I therefore began a series of experiments in which weighed quantities of the opium were thoroughly exhausted with water, and the extracts concentrated to a syrup, at a gentle heat on the water-bath, before precipitating the morphia. My general plan of procedure was to place 100 grains of the opium in a porcelain basin, add 1000 grains distilled water, and macerate frequently with a rubber-tipped glass rod. The digestion was allowed to go on all night, and the next day the strong aqueous solution of the opium, containing nearly all the morphia, was passed through a Swedish filter, taking care to leave the bulk of the insoluble matter in the basin. This residue was stirred up with several successive small quantities of water (each acting for ten minutes), and the total extract evaporated on the water-bath until it became of syrupy consistence. This was washed into a suitable bottle, using the smallest possible quantity of water for the purpose: 100 grains of alcohol (sp. gr. 0·825) and 300 grains of ether (sp. gr. 0·730) were then added, and the bottle gently rotated for a few minutes. Finally, 30 grains ammonia, sp. gr. 0·880, were added, the bottle frequently shaken, and allowed to stand twenty-four hours. The morphia was then thrown on to a weighed filter, and washed as completely as possible. first with morphiated spirit, and then with morphiated water, as suggested by the late Mr. E. F. Teschemacher. The filter was then dried at 212° F., and the increase of weight represented the amount of crude morphia present in 100 grains of the opium.

Unless I mistake their meaning, Messrs. Teschemacher and Smith appear to be under the impression that they are the only chemists who test the purity of the morphia precipitate by titration with standard acid.

If, however, they refer to the Chemical News (vol. lv., p. 69) they will find a letter of mine respecting Mr. Stillwell's process, in which I distinctly state that, instead of treating the precipitate with hot alcohol, I prefer to check my results by titrating the crude morphia with decinormal sulphuric acid. According to my experience the result, when calculated into pure morphia, generally comes out

about 0·25 per cent lower than the original weight of the precipitate.

During the last few months I have slightly altered my method of estimating the amount of morphia in samples of opium which have occasionally been sent to my Laboratory for examination. I now prefer to work on at least 200 grains of the opium (if that quantity be available), digest all night with ten times the amount of cold distilled water, and eventually completely exhaust with cold water in the manner already described. It will be noticed that I say *cold* water, because I think this preferable to using warm distilled water, as recommended by Messrs. Teschemacher and Smith. There can be no reasonable doubt about cold water extracting all the morphia from opium, and I fail to see the advantage of employing warm water, as there is then a risk of dissolving certain other ingredients of opium, which are more soluble in warm water than in cold. Even if these impurities are removed by the subsequent washings with the various purifying agents, it seems a pity to introduce them at all if their presence can be avoided.

To return to the description of my present method:—The total aqueous extract is evaporated on the water-bath to a small volume, transferred to the precipitating vessel, 100 fluid grains alcohol (sp. gr. 0·825) and 600 fluid grains ether (sp. gr. 0·730) are added, and the whole well mixed by gently rotating the bottle. Afterwards 45 fluid grains ammonia (sp. gr. 0·925) are added, and the remainder of the process conducted as usual.

With regard to the late Mr. E. F. Teschemacher's process, published in the Chemical News (vol. xxxv., p. 47), I must confess that it has always seemed to me to be so complicated that I thought loss must almost inevitably ensue at some stage or other; consequently I have very rarely employed it, but have latterly placed implicit reliance on the method which I have just described, and which I believe gives very accurate results. I propose, however, in the case of future samples of opium, to try the effect of purifying the precipitate of morphia by digestion with benzine, previous to the final weighing and titrating with acid, as Messrs. Teschemacher and Smith attach so much importance to that point.

Messrs. Teschemacher and Smith mention a case in which duplicate samples of opium were submitted to several chemists after being examined by themselves. All these chemists agreed closely with one another, but they found lower percentages of morphia than Messrs. Teschemacher and Smith. As I have good reason for believing that I was one of the analysts in question, perhaps I may be allowed to say that my results were obtained by the process upon which, as already mentioned, I have latterly staked my faith.

Chemical Laboratory, 9, Albert Square,
Manchester, March 24, 1888.

THE VOLUMETRIC ESTIMATION OF IODINE IN PRESENCE OF CHLORINE AND BROMINE.

By NORMAN McCULLOCH.

Monochloride and monobromide of iodine are compounds stable in strong solutions of free hydrochloric and hydrobromic acids; and consequently, if to a hydriodic acid solution containing not less than one-fourth, or preferably one-third of its bulk of strong hydrochloric acid, chlorine water, or decinormal permanganate be added, the iodine is completely converted to the monochloride; so—

$$10HI + 2K_2Mn_2O_8 + 22HCl = 4KCl + 4MnCl_2 + 16H_2O + 10ICl$$

and the solution no longer exhibits the characteristic reactions of free iodine.

(The applicability of permanganate to the above purpose will be understood from the well-known reaction of permanganic acid with hydrochloric acid, in which the chlorine of the latter is set at liberty).

On these facts, then, I base my process for the volumetric estimation of iodine in presence of chlorine and bromine, and it will be marked that in principle it closely resembles the chlorine method of Besseyre and Dupré.

This latter process, though aiming at the conversion of the iodine to iodic acid, is adapted neither to the titration of iodine in strong solution, or in any solution containing much *free* hydrochloric or hydrobromic acid, whereas, with the former or my own procedure, practically any quantity of iodine may be conveniently estimated, and in presence, too, of large proportion of hydrochloric or hydrobromic acid, which is really *essential* to the accuracy of the method.

I have operated in my experiments on potassium iodide, the salt being previously dried at 100° C., and standardised by a volumetric method described in "The Estimation of Iodine" (Chemical News, lvii., p. 45). This procedure consisted in dissolving 50 grains of the potassium iodide in 8 ozs. of water acidified with 1 oz. dilute sulphuric acid (one part H_2SO_4 + two parts H_2O), and 1½ ozs. of hydrocyanic acid (3 per cent), and adding thereto a weighed quantity of potassium permanganate (standardised with ferrous ammonium sulphate) with agitation *immediately* following to assist solution of the precipitated iodine and manganic hydroxide. The clear reddish brown colour of the resulting solution was now discharged by further addition of permanganate in standard solution, and then replaced by permanent pink of permanganic acid on complete conversion of iodine to cyanogen iodide, so—

$$10HI + 10HCN + 2K_2Mn_2O_8 + 6H_2SO_4 = 2K_2SO_4 + 4MnSO_4 + 16H_2O + 10ICN.$$

As the result of four almost exactly agreeing experiments the potassium iodide contained 76·00 per cent of iodine.

A weighed quantity of this standardised salt was transferred to a separating funnel of about 8 ozs. capacity, dissolved in a convenient quantity of water, and the solution mixed with its own bulk of strong hydrochloric acid. To this was added 20 or 30 grains (vol.) chloroform, and the permanganate now dropped in, with thorough agitation of the titrated liquid after each addition.

With the progress of the ensuing reaction, the fine violet tint of the chloroform faded as its dissolved iodine changed to the colourless monochloride, and a single drop of permanganate sufficed to completely decolourise the chloroform from a perceptible pink.

I have found that *strong* solutions (about 3 per cent) of iodine monobromide communicate to chloroform a faint yellowish pink colour, but quite distinguishable from the tint peculiar to free iodine.

Results of my experiments are shown in Table I.

Table I.

Iodine taken.	Other substances taken.	Iodine found.
15·23	1 oz. HCl.	15·23
2·32	,,	2·31
1·72	,,	1·71
15·25	,, +50 grains KBr.	15·23
0·86	,, ,, ,,	0·86
0·09	,, ,, ,,	0·08

I have investigated the applicability of the above volumetric process to the estimation of iodine in presence of hydrocyanic acid, and, as will be seen from the experiments of Table II., with fairly satisfactory results.

Table II.

Iodine taken.	Other substances taken.	Iodine found.
3·13	½ oz. HCl+6 grains HCN.	3·14
3·13	,, ,, ,,	3·13
0·09	,, ,, ,,	0·11
0·61	,, ,, ,,	0·63
0·61	,, 60 grains ,,	0·61

The influence of the hydrocyanic acid is to render the results somewhat high, and, curious to say, to a most marked degree in presence of hydrobromic acid, so much so that the process is not applicable under the circumstances.

I suppose we must attribute this to the formation of cyanogen bromide, a compound of only feeble oxidising powers.

Laboratory of Clyde Iron Works (by Tollcross), Glasgow, March 7, 1888.

ON THE RANGE OF MOLECULAR FORCES.*

By A. W. RÜCKER, M.A., F.R.S.

(Continued from p. 124).

Another method of investigating the magnitude of the radius of molecular action is based on the phenomenon of electrolytic polarisation. If we immerse in acidulated water two similar metal plates which are not attacked by the acid, they will be at the same potential. When a current is passed from the one to the other they will, if the metal and acid have been properly chosen, become covered with films of oxygen and hydrogen respectively. The sum of the differences of potential due to metal/gas/liquid, is not the same as that due to the single metal/liquid contact, and varies with the nature of the gas. Hence the coated plates assume different potentials, but the full difference is not established until the surface-density of the deposited gas exceeds a certain value. If then we suppose that the film is uniform, and that the metal and liquid cannot be regarded as completely separated until the thickness of the film exceeds the radius of molecular action, we may by plausible assumptions as to the density of the gas estimate its magnitude.

Thus F. Kohlrausch (*Pogg. Ann.*, cxlviii., 153, 1873), concluded that if the gases are supposed to be at their ordinary densities the polarisation of a platinum electrode is complete when it is coated with a layer of oxygen 20 $\mu.\mu.$ in thickness. It is evident that the assumption as to the density of the gas is totally at variance with the views ordinarily put forward in discussions on the condensation of gases on solids as to the great molecular pressure to which the condensed film is subjected, and that doubt on this point deprives such observations of all value for our present purpose. To reduce the uncertainty as to the density of the polarising layer, it is evidently better to substitute another metal for a gas. This has recently been done by Oberbeck (*Wied. Ann.*, xxxi., 337, 1887).

The films were deposited on platinum electrodes, and the liquids used were solutions of $ZnSO_4$, $CdSO_4$, and $CuSO_4$. Three platinum plates were immersed in the solution which was contained in a rectangular cell. Two plates of the metal of which the sulphate was used (zinc, say) were interposed between the central platinum plate and the other two, and were used as electrodes by means of which a layer of Zn was deposited on both sides of the central plate. Electrolysis was continued until the difference of potential between the coated plate and the external platinums, which were not affected by the current, was the same as that between Zn and Pt (1·13 Daniell). The current was then stopped, and for a time the electromotive force slowly diminished, after which a very rapid decrease was observed. The film was spontaneously redissolved, and the sudden change in the rate of the fall of the electromotive force was regarded as indicating that the thickness of the metallic layer had become less than the radius of molecular action.

If a is the quantity of metal deposited on each sq. c.m. (which could be calculated from the current strength, &c.); and

θ the time which elapsed after the completion of the electrolysis before the rapid fall of E.M.F.,

it was found that these quantities were connected by a relation of the form—

$$a = A + B\theta,$$

where A and B are constants.

Of these A is the quantity of Zn on each sq. c.m., when its thickness is just less than the radius of molecular action, and by means of two experiments in which a and θ have different values it can be calculated. Oberbeck concludes that if the specific gravities of the electrolytic layers are the same as those of the metals under ordinary circumstances, the thicknesses necessary to establish the full difference of potential are between 2 and 3 $\mu.\mu.$ for zinc, between 1 and 2 $\mu.\mu.$ for cadmium, and rather less than 1 $\mu.\mu.$ for copper.

Interesting as these results are, they are open, as Oberbeck himself points out, to criticism. The rapid decrease in the E.M.F. might be explained by supposing that when the zinc layer becomes very thin, parts of the platinum plate are uncovered, and that local action takes place which rapidly dissolves the zinc. This is certain to occur unless the metallic film is uniform. To test its uniformity the experiment was repeated with a solution of acetate of lead as the electrolytic liquid. The colour of the platinum electrode showed that the deposit was uniform over the greater part of the plate, but was slightly thicker towards the edges. No data as to the colours displayed are given, but unless the difference of the tints was very slight it would correspond to a variation of thickness greater than that assigned to the radius of molecular action.

The next method which I propose to describe aims at a measurement of the distance between two consecutive layers of molecules. If plates of Zn and Cu are connected by a metallic wire, they assume different potentials (P and p), the Zn becomes positively the Cu negatively electrified. When the plates are parallel to each other, and separated by a distance t centimetres, they form a condenser, and if $+e$ is the charge upon 1 sq. c.m. the Zn plate $e = (P-p)\,4\pi t$.

Hence et is a constant which depends only on the nature of the metals, and is independent of the distance between them. When the metals are in contact the potential difference remains unaltered, and we may regard the surface molecules as being oppositely charged and separated by a very small interval. The two charges are said by Von Helmholtz to constitute an *electric double layer* (*Pog. Ann.*, lxxxix., 211, 1853; *Wied. Ann*, vii., 337, 1879).

The mutual action of two metals, or of a metal and liquid when in contact, is therefore the resultant of the molecular forces and the electrical attractions and repulsions which are in play between the different parts of the double layer.

Thus Von Helmholtz (*Berlin Wissenschaft. Abh.*, 925, 1882; see also *Wied. Ann.*, xvi., 31, 1882) has proved theoretically that the surface-tension depends on the electrical charge, and is a maximum when it vanishes, and, as is well known, Lippmann (*Annales de Chemie*, v., 494, 1875) has shown that the surface-tension of mercury in contact with dilute acid is a function of the difference of potential between them, and that every motion of the common surface changes the potential difference in such a way as to produce an alteration in the surface-tension which checks the motion. By means of a theory which it is unnecessary to reproduce here, he (*Comptes Rendus*, xcv., 687, 1882) drew from his experiments the conclusion that for such differences of potential as he employed the capacity of a given area of a Hg/H_2O surface is constant. Hence the distance between the two electrified surfaces is constant, and can be deduced from the theory. The value found is 0·03 $\mu.\mu.$ Oberbeck (*Wied. Ann.*, xxi., 157, 1884) and Falck have measured the electromotive force of polarisation produced by alternating currents on metals immersed in solutions of K_2SO_4, KCl, KBr, and KI. They conclude that the capacity of the double layer is not constant, but is a function of the charge, so that its thickness must be regarded as variable. They deduce, however, its

* A Lecture delivered before the Chemical Society, Feb. 2, 1888.

limiting value when the charge is zero, *i.e.*, the distance between the nearest layers of molecules under normal conditions when no current is passing. The magnitude of this initial value depends more on the metal than on the liquid. The following Table holds for solutions of KCl or KBr, and gives the thickness of the double layer deduced rrom the formula—

$$t = 1/4\pi C,$$

where C is the initial capacity.

Metal.	t in terms of 1 $\mu.\mu.$
Nickel	1·04
Aluminium	0·67
Gold	0·06
Silver	0·02

When dimensions so small as these are reached the validity of the method of representing the phenomenon as due to two uniform layers of electricity is very doubtful. The values of t in the case of gold and silver are comparable with the diameters of the molecules themselves, and thus t can only be regarded as a conventional length representing the thickness of an artificial condenser by which the real molecular arrangements may be approximately imitated.

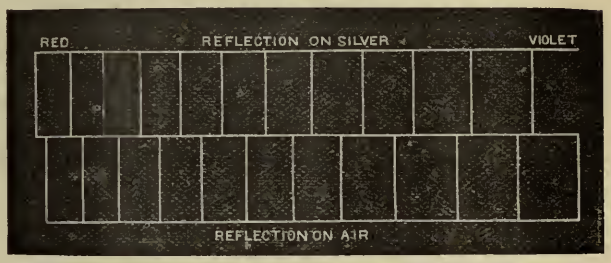
L. Lorenz (*Pog. Ann.*, cxl., 644, 1870) has also based upon electrical theory an estimate of the distance between neighbouring water molecules. He concludes that it is $< 0{\cdot}1\ \mu.\mu.$

A very interesting paper has lately been published by O. Wiener (*Wied. Ann.*, xxxi., 629, 1887), in which he attacks the problem of the determination of the thickness of the thinnest metallic plate which affects reflected light in the same way as a thick plate of the same metal.

It is well known that in general when light passes from a less dense to a more dense transparent medium, the phase of the reflected ray is altered by half a wave-length. This is proved by the fact that the centre of Newton's rings as seen by reflected light is black. For the difference in the phases of the rays reflected from the front and back surfaces of the film respectively depends partly on the thickness of the film and partly on any change of phase which the rays may undergo on reflection or refraction. As the film becomes very thin the difference in the paths of the two rays due to its thickness becomes negligible, and thus if the phase were not affected by reflection or refraction, the rays reflected from the centre of the rings where the film is thinnest would be nearly in accord, or the centre would be bright when viewed by reflected light. The fact that the centre is dark is explained by the assumption that when a ray of light passes from a less dense to a more dense transparent medium the phase of the reflected ray is altered by half a wave-length.

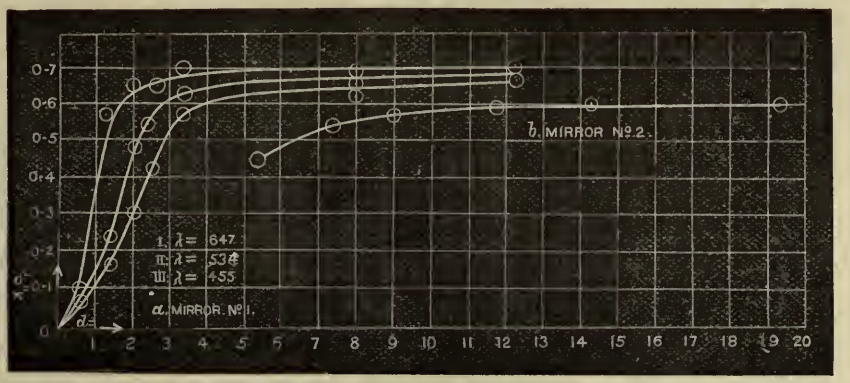
When light is reflected at a metallic surface an alteration of phase also takes place, but it is not necessarily half a wave-length, and it is on this peculiarity that Wiener's method is based.

In the light reflected from a thin film of air enclosed between the two glass plates, those rays will be wanting for which the difference of phase produced (1) by the difference in the lengths of the paths of the rays reflected at the first and second surfaces, and (2) by the change of half a wave-length produced on reflection at the air-glass surface is an odd multiple of half a wave-length. In the spectrum of such light, dark interference bands will be visible corresponding to the missing rays. If the second surface had been silvered (the thickness of the air-film



remaining unaltered) the effect of the first of the above two causes would be the same as before, but that of the second would be different. Hence the particular kind of light for which the total retardation was previously an odd multiple of the half-wave length would no longer satisfy that condition, and the interference bands in the spectrum would occupy new positions. If the second surface had been partly silvered, two contiguous spectra could be obtained in which the interference bands appeared broken.

In the experiments with which we are specially concerned Wiener proceeded as follows:—A thin film of mica was partly covered by a second with a straight-edge. Silver was deposited on it by discharge from a silver electrode (*Wied. Ann.*, xxix., 353, 1886). The layer thus formed was thickest in the centre, and thinned away gradually. When the covering mica was removed the silver film was bounded on one side by a straight line. Thus when light was reflected from the film on to the slit of a spectroscope (the silvered side being furthest from the instrument), two spectra were seen side by side, as is shown in the figure. The displacement of the interference bands varied with the thickness of the film, but became constant when the thickness exceeded a certain value. It was measured for certain parts of the spectrum at a number of points, the positions of which on the mica were determined. The silver was then converted into silver iodide, and the displacement of the interference bands was again determined at the selected points. From this latter measurement the thickness of the iodide, and therefore of the original silver film, could be deduced by formulæ, for the discussion of which I must refer to the



original paper (*loc. cit.*, p. 664). Curves were then drawn, showing the relation between the thickness of the silver and the change of phase produced by it. These are reproduced in the figure. Curves I., II., and III. were obtained by the same mirror, but by observations in different parts of the spectrum. Curve I. corresponds to the orange ($\lambda=647$), II. to the green ($\lambda=534$), and III. to the blue ($\lambda=455$). The retardation increases very rapidly for the blue, less rapidly for the other colours, till a thickness of about 4 $\mu.\mu.$ is attained. Afterwards it alters more slowly, and is nearly constant at the greatest thickness for which the measurements were made, viz., 12 $\mu.\mu.$

Observations made with another mirror confirmed the result that the change of phase reached its maximum value for a thickness of about 12 $\mu.\mu.$, but indicated a more uniform rate of increase. Herr Wiener ascribes this difference to a slight oxidation of the silver films.

The smallest thickness for which any displacement of the bands could be observed is estimated as rather less than 0·2 $\mu.\mu.$

(To be continued).

ON THE OCCURRENCE IN NATURE OF COPPER ANTIMONIDE.

By A. LAIST and T. H. NORTON.

Combinations of copper and antimony have hitherto been known only in the form of the four alloys prepared by Calvert and Johnson,* and Christofle.† Recently a large deposit of an antimonide of copper has been discovered in the eastern part of Asia Minor, not far from Mytilene. We are indebted to the courtesy of Mr. Archag Melcon for samples taken from an extensive vein underlying the entire area of a Turkish village, and easily accessible from the surface.

The new mineral resembles native silver in colour. The freshly fractured surface is quite lustrous, but tarnishes easily, especially in air containing sulphuretted hydrogen. It is of massive structure, no traces of crystallisation or distinct planes of cleavage being detected. It is quite brittle, with very uneven fracture, and in hardness it stands between fluor spar and apatite, *i.e.*, on the scale 4—5. The fusibility in the reducing flame lies between that of antimony glance and of natrolite.

The high specific gravity of the mineral is its most striking physical characteristic. This was found to be 8·812 as the mean of three closely agreeing determinations. It is worthy of note that but a limited number of minerals possess a higher specific gravity.

A qualitative examination showed the sample of the mineral to be a perfectly pure compound of copper and antimony, free from other metals, and also free from gangue.

The quantitative analyses gave the following results :—

	I.	II.	III.	Average.
Cu ..	73·45	73·74	72·92	73·37
Sb ..	27·05	26·90	26·62	26·86
	100·50	100·64	99·54	100·23

The analytical results give figures lying between those required by the two simple molecular expressions Cu_5Sb and Cu_6Sb, and approximate still more closely to the combination $Cu_{11}Sb_2$.

Cu_5Sb.	Cu_6Sb.	$Cu_{11}Sb_2$.	Found.
72·42	75·6	74·39	73·37
27·58	24·4	25·61	26·86

* *Phil. Mag*, (4), xviii., 354.
† "Combinaisons de l'Antimoine avec les Métaux." Göttingen, 863.

It will be seen that the composition of this copper antimonide is not far removed from the stibio hexargentite variety of dyscrasite, the only native antimonide hitherto known, which Petersen* has shown to exist in two well-defined forms, Ag_3Sb and Ag_6Sb.

It seemed a matter of interest to prepare an artificial alloy of copper and antimony of the same composition as the mineral just described. Accordingly 200 grms. of copper and 74 grms. of antimony were fused together in a clay crucible and allowed to cool slowly. The regulus obtained weighed a few decigrms. less than 274 grms., and its composition therefore was—Copper 73 per cent, antimony 27 per cent.

In appearance it closely resembled the native mineral, although not quite so lustrous. It was also more brittle, probably on account of a more rapid congelation. The specific gravity was 8·829,—very slightly higher than that of the mineral, 8·812.

It may be mentioned in this connection that the specific gravity of this antimonide is notably higher than the theoretical figure for a mixture of copper and antimony in the proportions given, viz., 8·19, the difference being 0·622.

A similar fact was noticed by Calvert and Johnson† when experimenting on a combination of the two metals represented by the formula CuSb. The specific gravity found was 7·99, while that calculated was 7·38,—difference, 0·61.

With regard to the metallurgical utilisation of the large Asiatic deposit of this copper antimonide, it is doubtful whether the expense attendant upon the separation of the two metals would permit of successful competition, on the one hand, with stibnite, and on the other hand with the abundant American deposits of copper minerals. Probably the simplest method of treating the mineral would be to expose it to the action of hot dilute sulphuric acid, which would dissolve out the copper and leave an insoluble residue of antimony oxide. Experiment shows us that if an excess of the acid be avoided, all of the copper is extracted, and but a slight amount of antimony enters into solution.

Several alloys containing copper and antimony are used in the arts, and the mineral on account of its purity could be used directly in their preparation.

This new mineral is named Horsfordite, in honour of Prof. Horsford, formerly Rumford Professor of Chemistry at Harvard University.—*American Chemical Journal*, vol. x., No. 1.

AN EASY METHOD OF FINDING THE SPECIFIC GRAVITY OF LIQUIDS.

By ALFRED B. TAYLOR, Ph.M.

A new application of an old rule has suggested a method of finding the specific gravity of liquids which I have never seen mentioned, and which, from its simplicity and great ease of application, seems worthy of publication. By means of it the specific gravity of any liquid can be ascertained without calculation, or any apparatus other than a good balance and accurate weights.

It is known that the weight of a body is to its specific gravity as its loss of weight when immersed in a liquid is to the specific gravity of that liquid. For example:—200 grains of citric acid (sp. gr. 1·60) lose in weight 115 grains when weighed in oil; and as 200 is to 1·60, so is 115 to 0·920 the sp. gr. of the oil. Now if we make the weight of the citric acid the same number of grains as its specific gravity our formula becomes—As 1·60 is to 1·60, so is the loss in weight of the citric acid when weighed in oil to the specific gravity of the oil; or, in

* *Pogg. Ann.*, cxxxvii., 377.
† *Phil. Mag.* (4), xviii., 354.

other words, the loss of weight is equal to the specific gravity, from which we deduce the following general rule:—

The specific gravity of a liquid is equal to the loss of weight (in grains) sustained by a solid body when immersed in the liquid, the weight of the solid being equal (in grains) to its specific gravity.

Hence it is necessary only to weigh the solid in the liquid, and its loss gives at once the specific gravity of the liquid.

Taking the preceding example:—If 200 grains of citric acid lose 115 grains, 1·6 grains will lose 0·920 grain, and this loss is equal to the specific gravity of the oil.

In practice the weight of the solid might be 10 or 100 times the weight of its specific gravity, care being taken to put the decimal point in the right place in the final result.

As perhaps one of the most desirable solid bodies to use, I would suggest a piece of aluminium weighing 256 grains, the specific gravity of that metal being 2·56. If upon trial its specific gravity should vary from these figures, its weight should be made to correspond.

For liquids having greater specific gravity than 2·56, it would be necessary to use a heavier solid than aluminium. —*American Journal of Pharmacy*, vol. lx., No. 2.

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN,

General Monthly Meeting, Monday, April 2, 1888.

Sir James Crichton Browne, M.D., F.R.S., Manager, in the Chair.

The following were elected Members:—William Arthur Brailey, M.D., M.A., M.R.C.S., Thomas R. Dallmeyer, Samuel de Lissa, Walter Gilbey, Colonel Alexander Charles Hamilton, R.E., Robert Moon, and Fitzpatrick Praed.

Four Candidates for Membership were proposed for election.

The presents received since the last meeting were laid on the table, and the thanks of the members returned for the same.

NOTICES OF BOOKS.

Electrical Instrument-making for Amateurs. A Practica Handbook. By S. R. Bottone. London: Whittaker and Co.

The Preface to this book contains a statement which we are not prepared to accept. Says Mr. Bottone—"Nearly all the really useful inventions and discoveries which have rendered the nineteenth century so remarkable as a season of progress must be attributed to amateurs." With this assertion we are very far from agreeing, if we define the "amateur" as a man who does not make scientific or technical research the object of his life, but merely takes it up in the intervals of business or of amusement. Among practical inventions of unquestioned utility, the coal-tar colours, the Solvay alkali process, the improvements of Weldon and Deacon in the production of chlorine, the achievements of Bessemer and of Thomas and Gilchrist in steel-conversion, can certainly not be ascribed to amateurs. In discoveries, also,—though a discovery is rarely of immediate use,—the great steps taken in advance, such as the discovery of the conservation of energy, the periodic system of the elements, spectroscopy, the artificial production of organic compounds, electro-magnetism, the recognition of organic evolution, are the work of professional men of Science.

Passing over this questionable utterance, we are fully aware that amateurs have done good work, and may do so again, and that they—occasionally at least—develope into professed men of Science. Hence to assist them is a very laudable undertaking. One difficulty, however, remains: the amateur is, at the outset of his career, hampered by lack of time quite as much as by lack of funds. The question may therefore be raised whether he should spend his, perhaps, scanty leisure in manufacturing his appliances?

It seems to us that, in this country, the way of the beginner is made unnecessarily hard by the persistence of makers in giving to many kinds of scientific appliances an outside finish,—an ornamental character,—which adds much more to their cost than to their efficiency.

We by no means question the usefulness of the instruments made according to Mr. Bottone's instructions; but the time required will be a serious object, bearing in mind the occasional failures which are nearly certain to happen, and which will oblige the operator to do his work over again. To many persons, however, this work will be a useful guide, especially as the mere act of constructing the instruments will convey important lessons.

A Text-Book of Inorganic Chemistry. By Prof. Victor von Richter. Authorised Translation, by Edgar F. Smith. Third American from the Fifth German Edition. Carefully revised and corrected. Philadelphia: P. Blakiston, Son, and Co.

In addition to the text-books and handbooks of chemistry produced in this country we import no inconsiderable number of foreign manuals, some translated in England and some in the United States. We believe that in many cases an American writer can make better terms with a Continental author or publisher than can an Englishman, since he is not bound by any International copyright, and can, if he think fit, dispense with any permission.

The special feature claimed for Prof. von Richter's treatise is that it brings into prominence the relations existing between fact and theory. The periodic system is "made the basis of the present volume," and thermochemical phenomena are also taken into consideration. In the body of the work the entire discovery of the periodic law is ascribed to Profs. Mendeleeff and Lothar Meyer, who are said to have reached it almost simultaneously. In an Appendix—whether due to the author or the translator we are not certain—the prior claim of Mr. Newlands is admitted.

We must beg leave to differ from the author as to his classification of the sciences, which he divides into "general" and "special." Under the former head he places only mechanics, physics, and chemistry, omitting, it appears, astronomy, and breaking up biology. We think that nothing is gained by this arrangement, even as compared with that of Comte.

Everybody's Pocket Cyclopædia of Things Worth Knowing, Things Difficult to Remember, and Tables of Reference. London: Saxon and Co.

This little work certainly contains many things worth knowing, along with some others certainly not worth knowing, and a sprinkling of errors. Thus, in the first heading, "Historical Events, Handy Facts, and Notable Discoveries," we find it stated that "Daguerre and Nieper invented the process of Daguerreotype." It should be "Daguerre and Niepce."

On the same page we are told that the "electric light was invented by Lodayquin and Kossloff, at London, in 1874." Electric lights had been produced and exhibited long before that date and without the concurrence of the persons mentioned.

Further, "St. Elias, Rocky Mountains, is the highest peak in North America, 17,850 feet." A recent American authority gives its height as 19,500 feet.

Among antidotes for poisoning we find "milk or white of eggs in large quantities" recommended for sugar of lead or lead-water. A soluble sulphate, such as Epsom salts, will be preferable, as converting the lead into the almost insoluble sulphate. Cobalt is a substance so rarely met with that to prescribe an antidote in case of its use seems needless. On the other hand, a remedy for the effects of potassium cyanide would have been useful.

There is a Table giving the "common names of chemical compounds." Here we find chloroform described as "chloride of gormyle," doubtless a typographical error for formyle. Glucose is said to be the "common name" of grape-sugar. These two names would be improved by inversion. It would be well if the name "grape-sugar" were confined to the natural product, whilst the artificial compound — glucose *plus* impurities — should figure as starch-sugar. The "chemical names" here given are not, as a rule, those met with in modern text-books.

The Table of the Stature of Giants makes strong demands upon the reader's faith. We shall believe that De Vallemont (of Rouen) was 17 feet in height, Count Bucart (of Dauphiné) 22½ feet, Teutobach the same height, and an unknown of Palermo 30 feet, when their skeletons are produced.

Under "Origin of Great Inventions" we find the "circulation of the blood" (a discovery, not an invention!) ascribed to Servetus and Cinalpinus (Cæsalpinus?), and only "fully described" by Harvey. The electric light is here ascribed to Davy in 1813, which disagrees with a statement on an earlier page.

There is a list of the "100 greatest men of the world." This includes only twelve men of Science; among them we do not find Liebig, Faraday, or Darwin.

Under "Fifty Well-known People" we find enumerated twenty actors and musicians, and only two men of Science, Professors Huxley and Tyndall.

There are many other defects and errors in this little book to which we have not space to advert, but we may say that a revised and corrected edition would be of unquestionable use.

CORRESPONDENCE.

THE USE OF THE WORD "ASSAY."

To the Editor of the Chemical News.

Sir, — In their paper "On the Determination of the Amount of Morphia present in Opium," Messrs. E. F. Teschemacher and J. Denham Smith write (Chemical News, vol. lvii., p. 104):—"May we ask why Mr. Allen employs the term 'Assay of Morphia,' &c.? Do not let us Englishmen corrupt our own language. Surely 'assay' to a chemist involves the idea of furnacing of some sort."

Without contending that my view is necessarily the correct one, I may say that I give the word "assay" a somewhat broader signification than that adopted by Messrs. Teschemacher and Smith. My own ideas are expressed in the following words, which I quote from my "Commercial Organic Analysis," vol. i., p. 1:—

"The term 'analysis,' though originally meaning the separation or splitting up of a substance into its constituent parts, has now become greatly extended in its application, so that a process of chemical analysis may mean either—

"*a.* A true analysis, or separation of a substance into its constituent parts;

"*b.* A qualitative identification or recognition of a substance sought for; or

"*c,* A quantitative determination, with more or less accuracy, of the amount of a particular body.

"When the quantitative determination is limited to one or two important bodies which constitute the valuable or active constituents of a more complex substance, the analytical process is frequently called an '*assay*.' It is in this sense the term assay is employed throughout this work."

I fully admit that the term "assay" is sometimes restricted to dry methods of analysis, as in the opinion of your contributors it ought to be. In that case, however, what are we to say to the "wet assays" of iron and copper ores? Cannot we have an "assay" of sulphur ore, bleaching powder, or alkali unless the operation is conducted in a furnace? The term "assay" is probably more commonly associated with furnace operations in consequence of these being the first to attain an approximately quantitative character.

In conclusion, I may say that I cannot find in my writings the expression "Assay of Morphia," against my alleged use of which your contributors protest. In fact, unless commercial morphia itself were liable to be tested for the amount of pure or real morphia contained in it—just as commercial anthracene is assayed for the percentage of pure anthracene contained therein—I should not advisedly use the term. On the other hand, the "assay of opium for morphia" is a good example of the way in which I think the term "assay" should be employed.—I am, &c.,

Alfred H. Allen.

Sheffield, March 26, 1887.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 11, March 12, 1888.

On Phosphorus and Phosphoric Acid in Vegetation.—MM. Berthelot and G. André.—The authors conclude that the addition to a soil of phosphoric, and even to a certain degree of nitrogenous manures, after the time of the normal inflorescence of the crop, is useless, or at any rate sparingly fruitful. On the contrary, the addition of potassic manures may be serviceable up to about the cessation of vegetation, seeing that potash continues to be absorbed and to be active as long as the formation of woody matter continues, that is, even during the period of fructification.

A New Eolipyle, devised by M. Paquelin.—The apparatus consists (1) of a receiver of combustible liquid, depressed from above in the form of a circular channel, traversed vertically at its centre by a so-called central tube; (2) of a pipe placed above in the interior of the central tube, and forming a communication between the interior of the receiver and the space outside; (3) a chimney set astride the pipe and forming a continuation of the central tube; (4) a porous body arranged in the interior of the receiver around the central tube, and dividing the receiver into two super-imposed chambers, the upper and much the smaller of which is connected with the pipe, whilst the lower chamber contains the combustible matter. This apparatus works with petroleum ether; it has only one flame, is not subject to explosions, and can be used in any position. It gives a jet of flame from 0·15 to 0·18 metre in length, which melts silver, copper, and gold. It consumes only 90 grms. of fuel hourly.

Determination of the Two Red Rays of Potassium.—H. Deslandres—The author has determined the wave-lengths of two rays of potassium in the extreme red. The difficulty of the measurement turns on the slight

sensitiveness of the eye for these extreme rays. The use of the arc light has been necessary, and a grating on Rutherford's glass, the primary spectrum of which has a great intensity. With a rather wide slit the two rays are sufficiently visible. They are broad but distinctly reversible. The values adopted for the wave-lengths are: stronger ray, 766·30; fainter ray, 769·63; the mean being 767·965.

The Decreasing Solubility of the Sulphates.—A. Etard.—If the solubility of salts is represented by lines expressing the quantity of matter contained in 100 parts of solution, the author finds that for all the salts which he has had the opportunity of examining, this is a right line, the angular coefficient of which varies with each salt. For any saline matter the line of solubility does not remain constant in its direction. There always occurs a point of time when the angular coefficient changes its value, and even its sign, most commonly abruptly, but at other times after a perturbation more or less prolonged. The change in the sign of solubility is especially well established for the sulphates, and the author gives some new cases of their decreasing solubility.

Action of Roasting upon Several Oxides and Salts of Manganese.—Alex. Gorgen.—The anhydrous protoxides, if heated suddenly and strongly, leave red oxide; if roasted slowly, avoiding incandescence, and kept at dull redness until the weight of the residue is permanent, they yield sesquioxide. It heated to 200° to 430° the oxidation of the MnO obtained at a high temperature is very slow, and does not appear to go beyond manganite. The oxidation of protoxide prepared at dull redness, and effected for the same length of time below 430°, yields a peroxide less rich in oxygen than the sesquioxide. This action of the air between 200° and 430° cannot be studied directly upon protoxides obtained below 400°, since they are pyrophoric, some at 140° and others at common temperatures.

Formation-heat of Bibasic Sodium Glycerinate.—M. de Forcrand.—This paper is not adapted for useful abstraction.

Oxidation-Products of the Hydrazo-camphenes.—C. Tanret.—The author has studied the behaviour of the hydrazo-camphenes with nitric acid, the result being essentially terebenthic acid; also with sulphuric and chromic acids and melting potassa.

Moniteur Scientifique, Quesneville.
Series 4, Vol. i., December, 1887.

The Endosmose of Dutrochet, the Osmotic Analysis or Osmose of Dubrunfaut, and the Dialysis of Graham.—H. Leplay.—In 1826 Dutrochet discovered that if two liquids of different specific gravities are separated by a porous membrane, say a solution of salt on the one side and water on the other, there is set up a double current which he named endosmose, conveying water into the brine, and exosmose, conveying brine into the water. Dubrunfaut observed that of certain salts existing in mixed solution, some traverse an animal membrane more quickly than others, and on this fact he founded osmotic analysis. Graham established the fact that if a crystalline and a non-crystalline substance exist mixed in an aqueous solution, the crystalline body alone traverses the membrane, and on this fact he founded a classification of soluble bodies into colloids and crystalloids—a classification which, in M. Leplay's words "seduced chemists." Dubrunfaut shows the distinction between osmotic analysis and dialysis.

On Hydroquinone.—O. Hesse.—A controversial memoir from *Liebig's Annalen.*

Identity of the Photo-salts of Silver with the Matter of the Latent Photographic Image.—Carey Lea.—Already inserted.

The Struggle against the Phylloxera by Means of Maize.—The writer recommends the planting maize in the vineyards. The phylloxera leaves the vines to attack the maize. This method was proposed by M. Maumené as far back as 1874. It appears that the American vines are being destroyed by the phylloxera as well as the French vines.

Manufacture of Linoleum and of Wax Cloth at Kirkaldy.—From *Engineering.*

On Saccharine.—The *Revue de la Distillerie* points out that saccharine does not ferment, is not assimilated by the organism, and does not constitute a food. Its only legitimate use is in the preparation of medicines or foods for diabetic patients.

On Cholic Acid.—F. Mylius.—From the *Berichte der Deutschen Chem. Gesellschaft.*

On Blue Iodide of Starch.—F. Mylius.—This compound contains an atom of hydrogen replaceable by metals.

Conclusions of Memoir on Rabies.—G. F. Dowdeswell, F.C.S.—A paper read before the Royal Society.

Inauguration of a Monument to Bretonneau, Velpau, and Trousseau at Tours.—The proceedings included the delivery of the customary *éloges.*

Industrial Society of Mulhouse.—Session, Sept. 14, 1887.

O. Scheurer wrote on the substitution of phosphorous acid for arsenious acid in the fixation of iron mordants. He admits that phosphorous acid is less energetic than arsenic, but states that its action is considerable.

Camille Kœchlin observed that arsenic quadruples the fixation of iron.

Session of October 12, 1887.

Camille Kœchlin wished to add to his statement on the effects of arsenic, that this increased fixation takes place only in the presence of alumina.

M. de Haen sent in a sample of a double antimony fluoride and ammonium sulphate, with a request that it might be tried in dyeing and printing. The experiments were entrusted to A. Frey, who was to examine at the same time the double antimony-sodium fluoride of Koepp and Co.

A. Schlumberger sent in a note on tempered mica and its use in the production of paper-hangings.—M. Breuer is about to study its applications in tissue-printing.

M. Binder read a summary of the researches of R. Benedikt, of Vienna, on turkey-red oils.

M. de Kostanecki sent in a note on the preparation of dinitroso-cresorcine, obtained by the reaction of nitrous acid upon cresorcine.

Synthesis of Glucose.—A. E. Tutton.—From *Nature.*

Free Sulphocyanic and Cyanic Acids and their Combinations with Ether and Alcohols.—From the *Journal fur Praktische Chemie.*

Fantastic Chemical Nomenclature.—Dr. Krause.—Under this title the author gives, in the *Chemiker Zeitung*, some well-merited and judicious strictures on such names as antipyrine and antifebrine. He fears that in no distant future we may encounter *contrathermine*, *contraignine*, and the like.

Bulletin de la Société Chimique de Paris.
Vol. xlviii., Nos. 6 and 7, October 5, 1887.

Combination of Glycol with Certain Aldehyds.—H Lochert.—The author has obtained ethylene-œnanthylidene oxide by the reaction of 1 vol. œnanthol upon 3 vols glycol for three days at the temperature of 125° to 130° in a sealed tube. He is making analogous experiments with valeral and isobutylic aldehyd.

Researches on Pheno-safranine.—P. Barbier and Leo Vignon.—The authors have taken up the study of pheno-safranine as the simplest of the safranines. They state that the safranines are formed by the condensation

of 1 mol. paradiamine and 2 mols. of an aromatic monamine, with the elimination of $4H_2$ under the influence of oxidising agents. They have discovered a new method of forming substituted safranines founded on the use of nitroso-dimethyl-aniline, and a new method of preparing the phenazines and amido-phenazines, setting out from the aromatic secondary monamines, such as diphenylamine and dicresylamine.

The Oxidation of Silver.—H. Le Chatelier.—The author shows that silver can be directly oxidised, like other metals, and presents in this respect no peculiarity. The tension of dissociation of silver oxide at 300° lies between 10 and 15 atmospheres.

November 5, 1887.

New Reaction of Aluminium Chloride: Syntheses in the Fatty Series.—Alp. Combes.—On throwing gradually into acetyl chloride, kept on the water-bath at 40°—50°, anhydrous aluminium chloride, there is a brisk reaction, which is facilitated by diluting the acetyl chloride with chloroform. Hydrochloric acid is evolved, and there is deposited a solid body, $C_{12}H_{14}O_6Al_2Cl_3$, which must be acetyl acetone. The decomposition of this body yields a liquid boiling at 136°, and having the composition $C_5H_8O_2$. Neither phosphorus trichloride nor acetyl chloride react upon it, even on prolonged boiling,

Derivatives of Acetyl Acetone: Syntheses of Polyatomic Alcohols.—Alp. Combes.—This paper does not admit of useful abstraction.

Action of Oils with Polarised Light.—M. Peter.—The author refers to a memoir on the same subject, by M. Bishop, in the *Journal de Pharmacie*, and to establish his simultaneity gives the results which he has already obtained. In many oils the rotatory power may serve to indicate the presence of foreign oils. In case of olive oil any foreign oils present either increase or diminish its rotatory power. Of all the characters employed in the examination of oils none persists in the free fatty acids: the rotatory power alone gives analogous figures in an oil, and in the mixture of fatty acids or soaps obtained from it.

MISCELLANEOUS.

Chemical Literature.—We beg to call attention to the catalogue of books on chemistry and the allied sciences issued by Mr. Clay, of Edinburgh. We do not believe that any other catalogue at all equal in completeness has been issued in Great Britain. It will be found rich in sets of journals and transactions which it is now very difficult to obtain complete.

The Absorption of Small Amounts of Sulphuretted Hydrogen for Quantitative Determinations.—M. Osmond.—The mixed gases are passed through a bulb apparatus in the several bulbs of which there are placed equal and known volumes of a standard solution of silver nitrate. No hydrogen sulphide can pass into one bulb before all the silver in the former bulb has been precipitated as sulphide.—*Zeitschrift. fur Anal. Chemie.*

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertiaing columns.

Chemical Designations.—Can you kindly inform me whether there are any restrictions in using the following:—Chemist, Analyst, Research Analyst, Consulting Chemist.—Enquirer.

Gold in Tin.—Can any of your readers inform me if gold is occasionly found in tin, to the extent of several ounces per ton.—H. L.

Earrings.—(Reply to Maria Tibus).—Zinc is usually too brittle for earrings. Nickel silver, an alloy of nickel, copper, and zinc,—called German silver,—though malleable and ductile, sometimes combined with arsenic, is unsuitable to be worn in the ears as rings. for blood poisoning would probably ensue. It is very dangerous to wear earrings which do not contain 24 carats of gold or silver therein, Many vendors of these ornaments merely wash the rings with gold.—Sarah Falbe.

MEETINGS FOR THE WEEK.

Monday, 9th.—Medical, 8.30.
— Society of Arts, 8. "Milk Supply, and Butter and Cheese Making," by Richard Bannister, F.I.C., F.C.S.
— Society of Chemical Industry, 8. "The Errors and Defects of the Present Revenue System of Charging the Duty on Spirits and the Means for Remedying them," by Dr. B. Derham.

Tuesday, 10th.—Institution of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Photographic, 8.
— Royal Institution, 3. "John Ruskin," by Charles Waldstein, Ph.D.

Wednesday, 11th.—Geological, 8.
— Microscopical, 8.
— Pharmaceutical, 8.
— Society of Arts, 8. "Recent Legislation concerning the Pollution of Air and Water," by Alfred Fletcher, Chief Inspector of Alkali, &c., Works.

Thursday, 12th.—Royal, 4.30.
— Mathematical, 8.
— Telegraphic Engineers, 8.
— Royal Institution, 3. "The Chemical Arts," by Professor Dewar, M.A., F.R.S.

Friday, 13th.—Quekett Club, 8.
— Royal Institution, 9. "The Pygmy Races of Men," by Professor Flower, C.B., LL.D., F.R.S.
— Society of Arts, 8. "The Experiences of Twenty Years in Conducting Agricultural Inquiries in Southern India," by W. R. Robinson, M.R.A.C.

Saturday, 14th.—Physical, 3. "On the Measurement of the E.M.F. of Dynamos," by Prof. W. E. Ayrton, F.R.S., and Prof. Perry, F.R.S. "On the Variation of the Coefficients of Induction," by W. E. Sumpner, B.Sc. "Some Experiments on Soap-Bubbles," by C. V. Boys. "On Electromotive Forces by Contact," by C. D. Burton, B.Sc.
— Royal Institution, 3. "The Later Works of Richard Wagner," by Carl Armbruster.

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WILLIAMS and NORGATE, 14, Henrietta Street, Covent Garden, London; and 20, South Frederick Street, Edinburgh.
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TO MANUFACTURING CHEMISTS and OTHERS.

THE METROPOLITAN BOARD OF WORKS will meet at the Office of the Board, Spring Gardens, S.W., on Friday, the 13th day of April, 1888, at 12 o'clock at noon precisely, and will then be prepared to open TENDERS by parties who may be willing to CONTRACT for the SUPPLY of 2000 tons of MANGANATE of SODA, to be delivered at the rate of 100 tons per week from the first week in May next.

Parties desirous to submit Tenders may obtain a copy of the Specification, Form of Tender, and information as to the places of delivery, on application to the Chemist of the Board, at the Office, Spring Gardens, between the hours of 9 a.m. and 4 p.m. (on Saturdays between the hours of 9 a.m. and 3 p.m.), until Thursday, the 12th day of April, 1888. The Tenders, which must be on the Form supplied from this Office, and addressed to the Clerk of the Board, are to be delivered at the Office before 4 o'clock on the last-mentioned day, and no Tender will be received after that hour. The parties tendering must be in attendance at the Board at 12 o'clock on the day appointed for opening Tenders, and any Tender which is not fully filled up in every particular will be rejected. The Board do not bind themselves to accept the lowest or any Tender.

J. E. WAKEFIELD, Clerk of the Board.
Spring Gardens, S.W., 29th March, 1888.

THE CHEMICAL NEWS.

Vol. LVII. No. 1481.

ELECTRIFICATION AND ELECTROLYSIS.

By THOMAS T. P. BRUCE WARREN.

The term "electrification" is applied to two distinct phases of electrical action. The development of electricity by cleavage, pressure, &c., are called methods of electrification (Ferguson's "Electricity," p. 70).

Telegraph engineers use this word to describe a different phenomenon altogether (Warren, *Brit. Assoc. Report*, 1869; *Phil. Mag.*, March, 1870; Jenkins, "Electricity and Magnetism," p. 255; Clark and Sabine, "Electrical Tables and Formulæ," p. 70).

In a paper which was read before the British Association in 1877, on "The Determination of Temperature Coefficients for Insulating Envelopes," this subject was re-examined by the writer. This paper was supplementary to that of 1869. In the sense alluded to here, electrification was applied to the increase of resistance due to prolonged contact with a battery. An insulated wire was said to be electrified for one, two, three, &c., minutes, when connected with a battery for the required time, previous to noting the deflection on a galvanometer due to leakage.

Considering this subject in relation to chemical physics, it is rather unfortunate that the word "electrification" is used in this twofold sense; however, I confine the use of this word to express the physical change in a substance which precedes or is antagonistic to electrolysis.

Electrification may be taken as indicating molecular stress; when a current is passed through a substance which is electrolysed by that current, we may assume that this substance cannot stand the molecular strain and decomposition results.

A substance easily decomposed is termed an electrolyte, one which allows free passage to a current; a conductor, and one which does not conduct (comparatively) at all, is termed an insulator. Now as conduction and insulation are simply comparative expressions for one phenomenon, we are quite right in speaking of the resistances of a conductor and insulator as merely relative.

Clark and Sabine, and the late Prof. Jenkin, are the only writers I have met with who have dealt with electrification in this way. A curious result which has not been specially noted is this: a conductor—like copper, for instance—has its resistance increased by an elevation of temperature, whereas insulators like india-rubber, gutta-percha, resins, oils, and fats, have their resistances diminished; in fact some of these, under certain conditions, are true electrolytes. Again, many liquids which are good insulators in one case become highly conducting, under the same current, when examined in metallic vessels portions of which pass into solution. In such cases the molecular stress has broken down through the presence of a substance which has an affinity for one of the principles contained in the compound insulator.

Hence it is necessary, in measuring the resistance of a liquid or solid, to use electrodes which remain chemically inactive.

The word "polarisation" has been used, unfortunately, in a more indiscriminate way by all writers. Under the action of a current the intervening particles of an insulator between two conductors become polarised by induction, and a sudden return of the particles to their normal condition may give rise to the disruptive discharge, but we must bear in mind that a sudden polarisation due to charging may also result in disruption. To avoid disruption in a highly charged coil the discharge may take place through a resistance, or the charge may be drawn off by instalments into a Leyden jar or condenser, which is then discharged, and the process repeated until the remaining charge can be safely withdrawn.

In this case the molecular stress has been brought about too suddenly. Electrification which can easily be noted on a delicate galvanometer may be taken as a measure of the rate and quantity of molecular stress.

I have no doubt but that a very great deal of information may be gained on the nature of solution, and similar phenomena, by a study of electrification and electrolysis: the behaviour of saline solutions and acids under different degrees of concentration shows that with a feeble current we may produce a change in resistance as if electrification had set in, whereas a stronger current produces unmistakable signs of electrolysis.

Hence in measuring the resistance of an electrolyte the weakest current possible should be used, and in stating the resistance it is of great importance to give the strength of current employed, and, as the *true* resistance of a substance remains constant under different battery powers, we have a means of ascertaining whether electrolysis has set in.

ON THE ALLOYS OF CALCIUM AND ZINC.

By T. H. NORTON and E. TWITCHELL.

A method for obtaining an alloy of calcium and zinc was briefly described in 1860 by Caron.* It consisted in heating together in a closed crucible a mixture of 3 parts calcium chloride, 4 parts zinc, and 1 part sodium. Caron states that by this process he was able to prepare alloys containing from 10 to 15 per cent of calcium.

With the desire of examining these alloys more closely and of testing their availability for the production of metallic calcium, the following experiments were instituted.

In three cases the proportions indicated by Caron were used. In two cases the amount of zinc was diminished by one half. The calcium chloride was first fused, and after congelation finely powdered. The zinc was introduced in the form of small clippings of sheet zinc, and the sodium in small fragments. The mixture was placed in a covered French clay crucible and heated in a furnace or muffle. When zinc flames appeared the temperature was reduced so as to cause a steady but slight volatilisation of zinc. After the lapse of 15—30 minutes the crucible was withdrawn from the fire and broken when cool. The alloy was found at the bottom in the form of a regulus.

The determination of the calcium in the alloys was made in some cases by the use of the "cyanide method," the zinc salt being removed from the mixture of precipitated zinc and calcium carbonates by treatment with a solution of potassium cyanide. In other cases the hydrochloric acid solution was precipitated by ammonia and ammonium sulphide and allowed to settle, when the calcium was precipitated as oxalate from an aliquot portion of the clear liquid.

Experiment I.

The mixture of 40 grms. zinc, 30 grms. calcium chloride, and 10 grms. sodium was strongly heated for 15 minutes. Zinc flames then appeared and the temperature was reduced. After further heating for 15 minutes, during which time puffs of zinc vapour were given off, the crucible was removed. The regulus weighed 18 grms. An analysis by the cyanide method gave—

Ca .. .. 2·28

* *Comptes Rendus*, l., 547.

The specific gravity was 6·8, and the melting-point 360° (the melting-point of zinc). This alloy was difficult to distinguish from pure zinc. It was malleable, and had the same crystalline structure as zinc. The low percentage of calcium was evidently due to the maintenance of too high a temperature during the operation.

Experiment II.

Mixture of 20 grms. zinc, 30 grms. calcium chloride, and 10 grms. sodium. The crucible was introduced into a muffle already heated to a bright red heat. After 25 minutes the crucible was removed. A zinc flame had been apparent during the entire time.

The regulus weighed 21·6 grms.

The analysis made by the sulphide method gave—

Ca .. .. 5·44

The melting-point was about 640°, coinciding very closely with the melting-point of potassium iodide, which was used for a comparative determination. The hardness was 3½.

Experiment III.

The same quantities were used as in the preceding experiment. The muffle was kept for 25 minutes at such a temperature that zinc flames were not evident except when the cover of the crucible was raised.

The regulus weighed 20·7 grms.

The analysis made by the sulphide method gave—

Ca 6 06

The specific gravity was 6·115. Melting-point about 640°. Hardness 3½. This alloy was of a shining white colour and quite brittle. The lustre did not become dull in the air at the ordinary temperature. At higher temperatures, but still far below the melting-point, it oxidised rapidly. It was not attacked by cold water.

Experiment IV.

The same proportions as in the first experiment were used. The crucible was heated in an open furnace for 30 minutes, zinc being sparingly volatilised during the entire time.

The regulus weighed 39·7 grms.

The analysis by the cyanide method gave—

Ca .. .. 4·97

The specific gravity was 6·24. Melting-point about 640°. Hardness 3½. This alloy had the same physical properties as that obtained in the third experiment. It possessed, however, a marked granular crystalline structure.

Experiment V.

The same charge was used as in the preceding experiment. The crucible was kept in the furnace for forty minutes, a slow volatilisation of zinc being constantly maintained.

The regulus weighed 41 grms.

The analysis by the cyanide method gave—

Ca .. .. 6·36

The specific gravity was 6·369.

The alloy closely resembled that obtained in the third experiment.

Experiments were made to obtain alloys richer in calcium by igniting samples of the alloys already described in porcelain crucibles, in a current of hydrogen so as to expel the zinc. In all cases, however, although zinc was driven off in notable amounts, still there was a proportionate loss of metallic calcium. The residual alloy, rich in calcium, was left in so spongy a condition that it oxidised immediately in contact with the air, and the crucibles likewise showed traces of being attacked.

The results of these experiments would tend to show that it is exceedingly difficult, if not impossible, to obtain by Caron's method zinc-calcium alloys containing more than 6—7 per cent of the latter metal. The notable raising of the melting point, due to the addition of small amounts of calcium to zinc, is worthy of attention.—*American Chemical Journal*, Vol. x., No. 1.

ON THE RANGE OF MOLECULAR FORCES.*

By A. W. RÜCKER, M.A., F.R.S.

(Continued from p. 138).

We have now reached the point at which we may investigate the inferior limit to the range of molecular forces, viz., the so-called radius of the molecules. This part of my subject has been so fully discussed by Sir William Thomson (*Natural Philosophy*, Thomson and Tait, Part II., 495, 1883; *Proc. Roy. Instit.*, 1883; *Exner's Rep.*, xxi., 182, 1885) and O. Meyer (*Die Kinetische Theorie der Gase*, 225, 1877) that it will be unnecessary for me to reproduce their arguments in full. I shall therefore content myself with shortly stating their results, and describing at greater length a more recent method developed by Dorn and Exner.

Sir William Thomson (*Natural Philosophy*, 502) concludes that the diameter of the gaseous molecule cannot be less than 0·02 $\mu.\mu.$, and that the distance from centre to nearest centre in solids and liquids may be estimated at from 0·07 to 0·02 $\mu.\mu.$

He points out that when plates of Zn and Cu, which are connected by a metal, approach each other, work is done in virtue of the attraction caused by their assuming different electrical potentials. If the plates are split up into an increasing number of thin layers and arranged Zn and Cu alternately, so that the thicknesses of the plates and of the intervening spaces are equal, the work done will vary as the square of the number of plates. If the thickness in question were 0·1 $\mu.\mu.$, the heat-equivalent of the work done would be sufficient to raise the temperature of the metals by 62° C., if it were 0·025 $\mu.\mu.$ the heat would suffice to raise the mass through 992° C. The conclusion is drawn that the molecules of Zn and Cu are probably at least 0·1 $\mu.\mu.$, and certainly more than 0·025 $\mu.\mu.$ in diameter. Again, when a liquid film is stretched, work is done upon it, and it is also cooled. To keep its temperature constant heat must be supplied, and if the thickness were reduced to 0·05 $\mu.\mu.$, the heat-equivalent of the total amount of energy imparted to the film would be about twice the latent heat of steam. As it is incredible that the film could absorb so large a quantity of energy and yet remain in the liquid state, it is certain that if it could be reduced to this extreme tenuity, the work done in stretching it would, *cæteris paribus*, be less when it was very thin than when it was relatively thick. Hence the surface-tension must diminish before the thickness of the film is 0·05 $\mu.\mu.$, and Sir William Thomson thinks that there cannot "be any considerable falling off in the contractile force as long as there are several molecules in the thickness. It is therefore probable there are not several molecules in a thickness of" 0·05 $\mu\ \mu$. From a consideration of the transmission of light through transparent bodies, he also concludes that the distance between the centres of contiguous molecules in solids and liquids is greater than 0·05 $\mu.\mu.$

The fourth method used by Sir William Thomson is based on the theory of gases. An important formula has been deduced by Clausius, and, in a slightly different form, by Maxwell, which establishes a relation between the diameter of the molecule (d), the mean free path (L), and the ratio of the total volume of the molecules to the volume of the gas (v). It may be written—

$$d = 6\sqrt{2}vL.$$

The value of v, which is called by Loschmidt the condensation coefficient, has been obtained in various ways.

* A Lecture delivered before the Chemical Society, Feb. 2, 1888.

Sir William Thomson concludes from the general results of experiments on the condensation of gases, that a gas could not be made 40,000 times denser than it is under ordinary atmospheric pressure and at ordinary temperatures. Hence $v > 25 \times 10^{-6}$.

Loschmidt (*Sitzungsber. Wien. Akad., Math. Classe*, lii., Abt. 2, 404, 1866) made use of Kopp's formula—specific volume = molecular weight divided by the density at the boiling-point—to calculate the densities in the liquid state of gases which had not been liquefied. He assigned to the various elements specific volumes somewhat different from those selected by Kopp. Thus assuming those of oxygen and nitrogen to be 11 and 12 respectively, the calculated densities are $16/11 = 1{\cdot}4545$, and $14/12 = 1{\cdot}1666$. Hence, taking air as a mixture of four parts of nitrogen and one of oxygen, he calculated the density in the liquid state to be 1·224. If the molecules are spheres, they will, when packed as closely as possible, occupy a space which bears to the sum of their volume the ratio 1·17 : 1. He assumes that in a liquid they are closely packed, and deduces as an approximation to the true density $1{\cdot}224 \times 1{\cdot}17 = 1{\cdot}5$ say. Hence $v = 0{\cdot}001293/1{\cdot}5 = 0{\cdot}00086$. He takes as the value of the mean free path 140 $\mu.\mu.$, whence $d = 1$ $\mu.\mu.$ If, however, we use the value of L given by Meyer (*Die Kinetische Theorie der Gase*, 140), viz., 95 $\mu.\mu.$, we get $d = 0{\cdot}68$ $\mu.\mu.$

O. Meyer (*Theorie der Gase*, 225), employing a similar method for nine substances, the density of which is known both in the fluid and gaseous states by direct experiment, found values for the molecular diameters which lie between 1·18 $\mu.\mu.$ for N_2O and 0·44 $\mu.\mu.$ for H_2O.

Dorn (*Wied. Ann.*, xiii., 378, 1881) and more recently Exner (*Rep. der Physik*, xxi., 446, 1885) have obtained the value of the so-called condensation-coefficient, v, in another way.

Clausius (*Die Mechanische Behandlung der Electricität*, iii., Abschnitt) has given a formula which connects K, the specific inductive capacity of a di-electric, and v as above defined, on the assumption that the molecules of the di-electric are conductors, and are surrounded by a non-conducting medium. This formula is—

$$v = \frac{K - 1}{K + 2}.$$

According to Maxwell's electro-magnetic theory of light, if n is the refractive index of the di-electric for rays of infinite wave-lengths $K = n^2$, at all events to a first approximation. This equation is not satisfactorily fulfilled in the case of liquids or easily condensible gases, partly, perhaps, because our knowledge of the law of dispersion is insufficient to enable us to calculate the value of n from the refractive indices of the comparatively short luminous and dark waves which have been studied experimentally. In the case of gases in which the dispersion is very small this difficulty is not met with. As the specific inductive capacity is also very nearly unity the experimental difficulties which attend its determinations are great. The first measurements of this kind were made by Boltzmann and Professors Ayrton and Perry. More recent observations of Klemencic are in good accord with the results obtained by Boltzmann. The agreement between the values of $\sqrt{K}$ and of n, as determined by Mascart, is not satisfactory for vapours, but is very close in the case of the more perfect gases. The following table is abstracted from that given by Klemencic (*Exner's Rep.*, xxi., 611, 1885) :—

	$\sqrt{K}$. Boltzmann.	$\sqrt{K}$. Klemencic.	n.
Air	1·000295	1·000293	1·000293
H_2	1·000132	1·000132	1·000139
CO_2	1·000473	1·000492	1·000454
CO	1·000345	1·000347	1·000335
N_2O	1·000497	1·000579	1·000516

This table shows that the value of v may be approximately determined in the case of gases for which we know either K or n. As v is the ratio of the space occupied by the molecules to the total volume of the body, of which the former is a constant and the latter varies inversely as the density (δ) of the substance, it is evident that for each substance v/δ should be a constant. Hence $(n^2 - 1)/\delta(n^2 + 2)$ should be the same at all temperatures and for all physical states of the same substance.

This result has been obtained independently from optical considerations by H. A. Lorentz (*Wied. Ann.*, ix., 641) and L. Lorentz (*Wied. Ann.*, xi., 70), and has been tested experimentally by the latter and Prytz (*Wied. Ann.*, xi., 104) in a large number of cases. Although the refractive indices are those for D, and not for waves of infinite length, the agreement is very close.

I give in the following table the first three substances mentioned in the final tables of these two observers as samples. The numbers compared are the values of $(n^2 - 1)/\delta(n^2 + 2)$ for the same substance in the liquid and gaseous states :—

Substance.	Observer.	Liquid.	Vapour.
Ethyl ether ..	L	0·30264	0·3068
Ethyl alcohol ..	,,	0·28042	0·2825
Water..	,,	0·20615	0·2068
Methyl alcohol..	P	0·2567	0·2559
Methyl acetate..	,,	0·2375	0·2399
Ethyl formate ..	,,	0·2437	0·2419

The following table contains the values of v for some of the elements. From Avogadro's law it follows that these numbers are proportional to the volumes of the molecules, and if we divide them by the number of atoms in the molecule we obtain numbers proportional to the atomic volumes. In the case of H_2 v was determined from the specific inductive capacity, in all other cases from the refractive index; and this and the next table I quote from Exner :—

Substance.	Molecular volume, $10^{-5} \times$	Atomic volume, $10^{-5} \times$
H_2	8·8	4·4
N_2	20	10
O_2	18	9
Cl_2	51	25
S_4	108	27
P_4	91	23
Hg	37	37
C (from CO − O)	—	14

From these atomic volumes it is of course possible to calculate the molecular volume of any compound of these substances. Thus the molecular volume of water = 8·8 + 9 = 18 nearly.

The following table gives the values of v obtained from K in the cases of the first five substances, and from n in that of the others, together with the calculated values deduced from the above atomic volumes :—

Substance.	v (observed), $10^{-5} \times$	v calculated, $10^{-5} \times$
Air	17*[20]	19
CO_2	31	32
N_2O	33	34
CH_4	31	32
C_2H_4	44	45
NH_3	26	23
H_2O	17	18
NO	20	19
H_2S	43	36
HCl	30	29
C_2N_2	56	48
SO_2	44	45

These results on the whole confirm the accuracy of the physical meaning of the expression $(n^2 - 1)/(n^2 + 2)$, and

* This number appears to be incorrect. Boltzmann's value for is 1·000590, which gives $v = 20 \times 10^{-5}$. This will be used hereafter.

tend to show that the diameter of the molecule is the same in the liquid and gaseous states. It is important to note, however, that from the theoretical point of view there is a good deal of confusion. The meaning of the expression $(K-1)/(K+2)$ is deduced from an electrical theory put forward by Clausius. It should only be equivalent to $(n^2-1)/(n^2+2)$ when n is calculated for waves of infinite length, and as a matter of fact K and n^2 are not equal for most vapours when n has a value proper to any of the visible rays. If then $(K-1)/\delta(K+2)$ is really the same for a liquid and its vapour, for neither of which n_∞ is known, we should not *primâ facie* expect that $(n^2_D-1)/\delta(n^2_D+2)$ would be the same for both.

Nevertheless experiment shows that the variations produced in this expression, by the passage from the liquid to the vaporous state, are less than the discrepancies due to the imperfect agreement between the values of K and n^2 in the case of most vapours for which both have been determined.

In cases where K is not $= n^2$, the value of v deduced from n^2 is to be preferred. Thus the specific inductive capacity of flint glass, as determined by Dr. Hopkinson (*Proc. Roy. Soc.*, xliii., 161), is 9·5, which makes v nearly $= 0·8$. If we assume the refractive index to have been 1·7, we get v rather less than 0·3, which is in far better agreement with the results obtained from gases. In the case of conductors the values of K are very high.

The annexed table gives the value of v for several liquids, calculated directly from K and n^2, as determined by Dr. Hopkinson (*loc. cit.*). The value is also given deduced from the atomic volumes of the gases, viz., 14×10^{-5} for C, and $4·4\times10^{-5}$ for H. Thus for the substance the chemical formula of which is C_nH_m, we have—

$$v=\frac{(14n+4·4m)\,10^{-5}}{\frac{12n+m}{2}\times0·00008961}\,D,$$

where D is the density of the liquid.

Substance.	Formula.	K.	μ^2.	v(K).	$v(\mu^2)$.	n calculated.
Amylene	C_5H_{10}	2·05	1·9044	0·260	0·232	0·237
Benzol	C_6H_6	2·38	2·2614	0·315	0·296	0·278
Toluol	C_7H_8	2·42	2·2470	0·321	0·291	0·286
Xylol	C_8H_{10}	2·39	2·2238	0·317	0·290	0·284
Cymol	$C_{10}H_{12}$	2·25	2·2254	0·294	0·290	0·295

In these cases, then, all three methods of calculating v indicate that from one-fourth to one-third of the volume of the liquid is filled with matter.

Another interesting point is that this method of regarding the formula $(n^2-1)/\delta(n^2+2)$ enables us to assign a physical meaning to the specific refraction of a substance.

In the above calculations it has been assumed that the atomic volume of a substance is the same, whatever the nature of its union with the other atoms may be. Landolt, however (*Liebig's Annalen*, ccxiii., 1882, 75), has undertaken a careful comparison of specific refractions calculated by the ordinary formula $(n-1)/\delta$ and by $(n^2-1)/\delta(n^2+2)$. He finds that the latter is more constant when the values obtained for the liquid and gaseous states are compared, and he calculates the specific atomic refractions by means of it. He finds it necessary to assign different values to O′ and O″, which, from the point of view we are discussing, indicates a difference of atomic volume. It must also be remarked that a very low value of the specific inductive capacity of air, when the pressure was 0·001 m.m., has been obtained by Profs. Ayrton and Perry, which might, if confirmed by future experiment, affect the questions we have been discussing. The following table of their results is abridged from Ayrton's "Practical Electricity," p. 310. The numbers which refer to air are alone extracted. The letter k indicates that the specific inductive capacity of air at 760 m.m. is taken as unity:—

Approximate pressure in m.m.	k.
0·001	0·994* (about)
5	0·9985
760	1·0000

They have in a pamphlet "On Certain Modifications that must be Introduced in the Fundamental Notions of the Mathematical Theory of Electricity," p. 5, proved that if δ be the density referred to air at 760 m.m. and 0° C. as unity, if 1·000294 be the refractive index of air under the same standard condition referred to that of a vacuum as unity, and if k be defined as above,—

$$k=\frac{0·000588\delta+1}{1·000588}.$$

This expression is obtained by Biot and Arago's formula $(n^2-1)/\delta =$ constant, but a practically identical result will be attained if we use instead the expression employed by Exner. It follows that k has a limiting value when $\delta=0$, such that if k_0 is the specific inductive capacity of a vacuum referred to that of air at 760 m.m. as unity, $k_0=1/1·000588=0·999412$. At 5 m.m. $k=0·999416$, as given by the formula. This agrees with the value obtained by Boltzmann, viz., 0·99941 ("Practical Electricity," *loc. cit.*), but is not in such close agreement with that obtained by Ayrton and Perry themselves. The difference might easily be ascribed to errors of experiment, but the value 0·994, when the pressure was 0·001 m.m., was obtained in a later research (*Rep. Brit. Ass.*, 1880). Its accuracy is independent of that of the measurements at a pressure of 5 m.m., and, as far as I am aware, no other observers have carried out experiments in gases of such extreme tenuity.

It is therefore much to be desired that further observations should be made on the specific inductive capacity of air at low pressures. The importance of such a research would be enhanced from the fact that it has been pointed out by Professor Fitzgerald (*Rep. Brit. Ass.*, 1880, *loc. cit.*) that the values obtained for the capacity of an air condenser between "about 0·02 and 0·2 m.m. pressure bear a general resemblance to those obtained for the Crookes's force." For my present purpose, however, it is sufficient to remark that if the ratio of the specific inductive capacities of air at pressures of 0·001 and 760 m.m. is about 0·994 : 1, then either Maxwell's theory fails when applied to rare gases, or the refractive indices of air at these pressures are in the ratio $\sqrt{0·994}$: 1, *i.e.*, 0·997 : 1. Now the fact that the refractive index from a vacuum to air at atmospheric pressure is about 1·000294, is proved not only by direct experiments on air of different densities, but also by the agreement between the observed and calculated results of the effect of atmospheric refraction on the apparent positions of stars. Hence, if we admit the validity both of the experimental determination of the specific inductive capacity of air, at a pressure of 0·001 m.m., and of the application of Maxwell's theory of this case, we must conclude that the refractive index of highly rarefied air referred to that of a vacuum as unity is—

$$0·997\times1·000294=0·997293,$$

* This number is correct. Prof. Ayrton informs me that that given in "Practical Electricity," viz., 0·94, is a misprint.

and that it is about 0·27 per cent less than that of a vacuum, The alteration in the ordinary refractive index of air which would be required to make this quantity > would make the calculated atmospheric refraction nearly ten times greater than that which is actually observed. It is therefore evident that either the experimental result is affected with error, or that Maxwell's theory does not apply to a rare gas. In either case the conclusions arrived at need not affect the application of Maxwell's theory to substances for which $K=n^2$, and for which, therefore, it appears to be at all events an approximation to the truth.

(To be continued).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Annual General Meeting, March 28th, 1888.

Mr. William Crookes, F.R.S., President, in the Chair.

The President delivered an address, of which the following is an abstract:—

The number of Fellows of the Society is 1571, of whom 37 are honorary foreign members. Eleven Fellows have died during the year:—Prof. C. L. Bloxam; J. B. Boussingault (foreign member); Patrick Duffy; J. J. Field; A. M. Graham; Dr. T. S. Humpidge; James Millar; A. Muter; H. H. MacMunns; W. B. Ritchie; Dr. Arthur Phillips; G. B. Sweeting; and A. E. Wilson.

11 Fellows have withdrawn:—L. M. Deane; H. W. Eve; G. F. Dowdeswell; G. Gladstone; Hugh R. Mill; Ed. Packard; T. A. Rickard; B. M. F. Rogers; C. A. Stitt; J. E. Tuit; and J. C. Wright.

30 Fellows have been removed on account of arrears:—Harry Allen; A. W. Bickerton; G. E Barker; Dr. H. C. Bartlett; Benjamin Browning; G. E. Basu; C. N. Betts; T. J. Barr; R. D. Courtney; Thomas Donnelly; W. T. H. Elsey; H. W. Fenner; Wm. Fox; Thos. Gibbs; G. A. George; Chas. Gillett; W. E. Heathfield; E. A. Harris; Edwin Lapper; R. T. Matthews; Alexr. Noble; Arthur Ness; O. Davies Owen; J. A. Ogilvie; Thos. Palmer; Matthew Percy; J. Schweitzer; Sidney Trivick; Rev. W. G. Whittam; and Wm. Wilson.

116 Fellows have been elected during the year, including 7 honorary foreign members.

There are 88 original Papers, occupying 871 pages, in the 1887 volume of the Transactions, as against 85 Papers of 865 pages in the 1886 volume. The Abstracts this year occupy 1159 pages, as against 1088 in 1886. The number of Abstracts is 2277, as against 2164 the average of the five years preceding. 108 Papers have been communicated to the Society during the session—10 fewer than in the previous session; but not a few have been of exceptional interest and value, a number of important questions having been brought forward for discussion: this view is confirmed by the fact that the Transactions contain a greater number of Papers than in any previous year.

The Longstaff Medal has been awarded by the Council to Dr. W. H. Perkin, F.R.S., in recognition of the importance of his researches on the magnetic rotatory polarisation of compounds in relation to their chemical constitution. The President said that he was sure the Society would cordially join with him in congratulating Dr. Longstaff that, although he is near the eve of his 89th birthday, he is still hale and hearty, and in expressing the hope that he may long be spared. In bestowing the medal he remarked:—

"It is not often that an opportunity such as that which has fallen to Dr. Perkin's lot is so fully made use of, and that one who has been engaged in industrial pursuits undertakes a research of such magnitude as that of which Dr. Perkin first gave an account to the Society in 1884 (*Trans.*, pp. 421—579), and which it is known has since wholly engaged his attention."

The cost of publishing the Transactions and Abstracts during the past year has been no less than £2116. It is to be expected, said the President, that as the number of Papers offered to the Society multiplies—as it surely will—and as the number of Papers to be abstracted augments, the cost will become even greater. Our publication is of such supreme importance to chemical science in this country, that the Society is not likely to shrink at necessary expenditure. But he felt impelled to refer to a question which ere long must be seriously considered, not only by us, but by scientific societies generally, viz., how far it is desirable that the same Paper should be published in more than one Journal. Our bye-laws only provide that authors shall not be at liberty, save by permission of the Council, to publish in English the papers they have communicated to the Society until such Papers, or abstracts of them, have either appeared in the Journal or have been returned to the writer. It must be taken for granted in this time of culture that a paper published in English, French, or German is thus made known to the entire scientific world, and, in the case of a Paper published in full in one of these three languages, it is unnecessary to give triple repetitions; an abstract of the essential facts, observations, and conclusions would be all sufficient. Some such curtailment will probably find favour, not only as a means of diminishing the cost of publication to individual societies, but also because it will put an end to the grievance undoubtedly felt by subscribers to scientific journals, of paying more than once for the same set of facts.

With perhaps two incomplete exceptions, we have not witnessed during the past session the dawn of any epoch-making, far reaching discovery which opens out new and tempting prospects of truth. The two exceptions are the researches of Krüss and Nilson, and the mathematical discussions of spectra by Professor Grünwald; these latter seem at least to foreshadow the conclusion that hydrogen, oxygen, carbon, and magnesium are not simple bodies but compounds, and if the phenomena admit of no other explanation, and if no unexpected source of error be detected, we may consider ourselves to be within measurable distance of a truly new chemistry. But here time must decide.

The President next drew particular attention to the tardy justice accorded to Mr. J. A. R. Newlands by the award of the Davy Medal of the Royal Society; and he referred to the action taken by Professor Frankland in bringing about the recognition of Mr. Newlands's claim to be the discoverer of the periodic law.

After remarking on the evils arising from the system of competitive examinations, and after deploring the action taken by the London University in making chemistry an optional subject at the Matriculation examination—by certain of the licensing bodies of the medical profession in allowing preliminary training in natural science to be obtained elsewhere than in a college or school with recognised facilities—and by the military authorities in handicapping the study of physical science, the President then proceeded to direct attention to the possible existence of bodies which are not elements in the strictest sense of the word—bodies which he terms meta-elements.*

Dr. Gladstone then moved that thanks be given to the President for his address, and that he be requested to allow it to be printed. The motion was seconded by Dr. Atkinson, and carried with acclamation. The President having replied, the Treasurer, Dr. Russell, gave an account of the financial condition of the Society. The receipts by admission fees and subscriptions had been £3158; by sale of Journal, £351 11s. 1d.: by dividends on invested capital, £317 12s. 9d.; the whole income

* The complete address "On Elements and Meta-elements" will appear in an early number of the Chemical News.

being £3896 2s. 10d. The expenses on account of the Journal had been £2116 10s. 4d.; on account of the Abstracts of Proceedings, £140 15s. 5d.; on account of the Library, £365 7s. 10d.; the total expenditure being £3194 1s. 4d.; £300 had been invested in Metropolitan Board of Works 3½ per cent stock, and there was a balance in hand of £1672 19s. 3d.

Dr. Stevenson moved that the thanks of the Society be tendered to the Treasurer for his services during the past session; Mr. J. A. R. Newlands seconded the motion. Dr. Russell acknowledged the vote.

A vote of thanks to the auditors was proposed by Professor Ramsay, seconded by Mr. Friswell, and acknowledged by Professor Dunstan.

Mr. Heaton proposed a vote of thanks to the Officers and Council; the vote was seconded by Professor Dunstan, and acknowledged by Dr. Armstrong.

Professor Clowes moved that the thanks of the Society be tendered to the Editors, Abstractors, and Librarian for their important services during the year. Dr. Plimpton seconded the motion. Mr. Groves and Dr. Thorne replied.

Messrs. Heron and Jackson having been appointed scrutators, a ballot was taken, and as result the following were declared elected as Officers and Council for the ensuing session:—

President: W. Crookes, F.R.S.

Vice-Presidents who have filled the office of President: Sir F. A. Abel, C.B., D.C.L., F.R.S.; Warren de la Rue, D.C.L., F.R.S.; E. Frankland, D.C.L., F.R.S.; J. H. Gilbert, Ph.D., F.R.S.; J. H. Gladstone, Ph.D., F.R.S.; A. W. Hofmann, D.C.L., F.R.S.; H. Müller, Ph.D., F.R.S.; W. Odling, M.B., F.R.S.; W. H. Perkin, Ph.D., F.R.S.; Sir Lyon Playfair, Ph.D., K.C.B., F.R.S.; Sir H. E. Roscoe, LL.D., F.R.S.; A. W. Williamson, LL.D., F.R.S.

Vice-Presidents: G. Carey Foster, F.R.S.; David Howard; J. W. Mallet, M.D., F.R.S.; H. McLeod, F.R.S.; Ludwig Mond; C. Schorlemmer, Ph.D., F.R.S.

Secretaries: H. E. Armstrong, Ph.D., F.R.S.; J. Millar Thomson, F.R.S.E.

Foreign Secretary: F. R. Japp, M.A., Ph.D., F.R.S.

Treasurer: W. J. Russell, Ph.D., F.R.S.

Ordinary Members of Council: Messrs. T. Carnelley, D.Sc.; A. H. Church; Frank Clowes, D.Sc.; Wyndham Dunstan; P. F. Frankland, Ph.D.; R. J. Friswell; Charles W. Heaton; E. Kinch; H. F. Morley, M.A.; R. T. Plimpton, Ph.D.; Thomas Purdie, B.Sc.; W. Ramsay, Ph.D.

Ordinary Meeting, April 5th, 1888.

Mr. William Crookes, F.R.S., President, in the Chair.

Messrs. Sidney Skinner, Arthur W. Clayden, and T. A. Elwood were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. John Campbell Fell, 15, Granby Street, N.W.; Albert Harrison, 66, Osborne Road, Forest Gate, E.; Egbert Grant Hooper, 24, Bloomfield Terrace, Buckingham Palace Road, S.W.; John Hughes, 3, West Street, Finsbury Circus; Henry James Kirkman, London Alkali Works, Swansea; William Parsons, 5, Earlsmead Road, South Tottenham, N.; Henry Charles Reynolds, 8, The Avenue, Clifton, Bristol; Frank Goodell Wait, University of Toronto, Canada.

The following papers were read:—

27. "*Researches on the Constitution of Azo- and Diazo-derivatives. III. Compounds of the Naphthaline β-Series.*" By R. Meldola, F.R.S., and F. J. East.

The authors describe the action of nitrous acid on the azo-compounds produced from the diazotised nitranilines and β-naphthylamine. The products vary according to the mode of operating; if the nitroazo-compound be dissolved in a large quantity of acetic acid and sodium nitrite be added to the cold solution, a diazo-compound is formed, which decomposes normally on boiling the solution, thus:—

$$NO_2{\cdot}C_6H_4{\cdot}N_2{\cdot}C_{10}H_6{\cdot}N_2{\cdot}OH = \\ = NO_2{\cdot}C_6H_4{\cdot}N_2{\cdot}C_{10}H_6{\cdot}OH + N_2.$$

If less acetic acid be used and the temperature be not allowed to exceed 60° to 70° at any stage of the operation, the change is of a different character, the acetic acid itself taking part:

$$NO_2{\cdot}C_6H_4{\cdot}N_2{\cdot}C_{10}H_6{\cdot}NH_2 + 2C_2H_3O{\cdot}OH + NaNO_2 = \\ = NO_2{\cdot}C_6H_4{\cdot}N_2{\cdot}C_{10}H_6{\cdot}OC_2H_3O + N_2 + C_2H_3O{\cdot}ONa.$$

The details of the methods are given in the paper. The authors propose to make a special study of this last interaction, which promises to be of general application as a means of displacing NH_2 by $-O{\cdot}C_2H_3O$. Metanitrobenzenazo-β-naphthyl acetate melts at 161° to 162°, and the corresponding paranitro-compound at 192° to 193°.

The authors have also found that the acetyl-derivatives of the azo-β-naphthol compounds can be obtained by direct acetylation by long boiling with acetic anhydride and anhydrous sodium acetate. Metanitrobenzeneazo-β-naphthyl acetate thus prepared is identical with that obtained from the corresponding β-naphthylamine-compound by means of the diazo-compound and acetic acid in the manner described. Benzeneazo-β-naphthyl acetate prepared by the acetylation of benzeneazo-β-naphthol forms orange scales melting at 117°. A detailed examination of the products of complete reduction of the acetyl- and alkyl-derivatives is in progress. The authors refrain from expressing any view as to the constitution of the naphthalene-β-azo-compounds till more experimental evidence has been obtained; but point out in conclusion that the present evidence indicates distinctly the presence of hydroxyl and amidogen in the β-oxyazo- and β-amidoazo-compounds of naphthalene respectively.

28. "*The Action of Finely Divided Metals on Solutions of Ferric Salts, and a Rapid Method for the Titration of the Latter.*" By D. J. Carnegie, B.A.

Ferric salts, whether in aqueous or acid solutions, are very rapidly, indeed almost instantaneously, reduced to ferrous salts by shaking with zinc-dust. The author describes a simple, very accurate, and very expeditious modification of the method for determining ferric salts by titration with permanganate, founded on this observation. The author considers that the zinc directly reduces the ferric salt, $Fe_2Cl_6Aq + Zn = ZnCl_2Aq + Fe_2Cl_4Aq$. If acid is not present some of the iron is precipitated partly as ferrous and partly as ferric hydroxide.

Many other finely-divided metals, besides zinc-dust, effect the reduction of ferric chloride; in every case examined the heat of formation of the chloride of the metal is greater than the negative value of the thermal change accompanying the passage from Fe_2Cl_6 to Fe_2Cl_4.

Discussion.

Professor Ramsay remarked that he had for some years past employed zinc-dust instead of granulated zinc or zinc-foil to effect the reduction of ferric salts. When ferric salts are reduced by stannous chloride, the excess of reducing agent can readily be removed by the addition of mercuric chloride to the solution previous to titration with bichromate.

Mr. Carnegie stated that the use of powdered zinc had been suggested some years ago by Brown: the reduction, however, took place in the presence of acid, and was not a direct chlorinating process, such as that referred to in the paper.

At the next meeting, on April 19, the following paper will be read:—

"The Influence of Temperature on the Composition and Solubility of Hydrated Calcium Sulphate and of Calcium Hydroxide," by W. A. Shenstone and J. Tudor Cundall.

NOTICES OF BOOKS.

The Fundamental Principles of Chemistry, practically taught by a New Method. By Robert Galloway, M.R.I.A., F.C.S., Author of "Education, Scientific and Technical." London: Longmans, Green, and Co.

What have we here? One of the many manuals, handbooks, and text-books of chemistry which for the last dozen years have showered from the press, and few of which have any clearly-marked *raison d'être?* Nay, good reader, or worthy outside critic who reviewest scientific works for the lay press! Something clearly different, as a few minutes' careful inspection will show you. For these routine manuals are, with exceptions few as angels' visits, mere abridgments of the great works of reference, such as Gmelin, or Roscoe and Schorlemmer. Such abstracts of encyclopædic treatises are evidently of little use as educational manuals. As the author clearly and forcibly puts it in his Preface, in such works the facts are unclassified; the generalisations are placed apart from the facts, and the technical language of the science is nowhere taught systematically,

Our author, as it will be seen, pursues a different method, and one which in our judgment will prove more profitable to the student. There is not, as Prof. J. P. Cooke puts it, "a weary catalogue of elementary substances involving a repetition of details as profitless to the general student as it is tedious and uninteresting."

In Prof. Galloway's system the facts brought forward are kept in an organic connection, and each is made to teach its lesson, so that the interest of the student is kept up. Thus the study, instead of being a mere burden for the memory, is made an exercise for the reason.

The work begins with a course of physics adapted to the course of pure chemistry which follows.

Thus the explanation of "porosity" is made to illustrate and teach porosity; the collection and storing of gases is shown under "impenetrability"; determination of boiling-points and fractional distillation under "adhesion." It will be remarked that the student is advised to pass over temporarily portions of certain chapters until he has made himself master of the technical language of chemistry as expounded in a subsequent chapter.

We find only two statements which we cannot accept. The author holds it as still uncertain whether fluorine has been obtained in the free state, and the arts of dyeing and tissue printing are explained too exclusively as based upon adhesion.

We hope that Mr. Galloway's work, and indeed his system of teaching, will receive a fair trial, feeling convinced that its advantages will not be slow in making themselves manifest.

A Practical Treatise on Animal and Vegetable Oils and Fats: comprising both Fixed and Volatile Oils, their Physical and Chemical Properties and Uses, the manner of Extracting and Refining them, and Practical Rules for Testing them; as well as the Manufacture of Artificial Butter, Lubricants, including Mineral Lubricating Oils, &c.; and on Ozokerite. Edited chiefly from the German of Drs. Karl Schaedler, G. W. Askison, and R. Brunner, with Additions and Lists of American Patents relating to the Extraction, Rendering, Refining, Decomposing, and Bleaching of Fats and Oils. By W. T. Brannt. Illustrated by 244 Engravings. Philadelphia: Baird and Co. London: Sampson Low, Marston, and Co.

This work, though running to 700 pages, covers such an extent of ground, that some of the subjects are scarcely treated in as full a manner as it might be desired.

The author opens with an account of the sources of fats and oils, those of vegetable origin being arranged according to the families to which they belong. Here we find a very useful table of the percentages of oil in seeds or fruits, ranging from 60 to 67 in Brazil nuts down to 1 to 1·5 in barley. It will perhaps surprise some readers to learn that the olive ranks low in the list, containing only from 12 to 20 per cent. To this table is premised the remark that the percentage of oils in seeds and fruits is inversely as that of sugar and starch.

The second chapter discusses the physical properties of the fats and oils. It is found that—of course at similar temperatures—fats from tropical climates are as a rule more solid than those from cold climates. The qualities considered are—Consistency (castor oil, *e.g.*, being at 59° F. 203 times more consistent than distilled water), capillarity, odour, taste, colour, and solubility. It is mentioned that fats and oils are not, as commonly supposed, absolutely insoluble in water. The next points considered are—Neutrality,—fatty substances being pronounced neutral to blue litmus,—changes on exposure to air, and combustibility. The table of relative combustibility gives the highest value to plum-kernel and olive oils, and the lowest to black mustard-seed oil. There is also a table of specific gravities.

In the third chapter the author turns to the chemical constitution of fats and oils.

We next come to the methods of obtaining the fixed oils, by pressure and by extraction with solvents, such as carbon disulphide and petroleum ether, the latter having the preference chiefly when the oil is intended for perfumery or culinary purposes.

For purifying oils there is mention of sulphuric acid, zinc chloride, chromates, manganates, &c. Tannin has not been found to give favourable results. The dregs from rendering tallow are now extracted with carbon disulphide, yielding about 10 per cent of an inferior fat, whilst the nitrogenous residue can still serve in the manufacture of glue or ferrocyanides.

The information here given concerning the movements of the cod on the Norwegian coast, and the proportion of cod-liver oil, is not quite correct. The fish appear at the Lofotens in January. It is not brought out with sufficient clearness that all the yellow and brown oils, no matter how carefully treated, owe their colour to incipient decomposition. Hence all such qualities are more or less rancid, and are much more apt to disturb the stomach than the oil in its original colourless state. It is an error to assert that the colourless oils have been artificially bleached. No such statement, however, is made in the work before us. The author, quite correctly, denies that the cod-liver oil is adulterated in Norway. That operation, if performed at all, is executed by importers.

Culachan oil, obtained from *Thaleicthys pacificus*, on the coasts of British Columbia and Alaska, is said to be more easy of digestion than cod-liver oil, but to assume a lard-like consistency even at ordinary temperatures, an inconvenience which might be overcome by removing the stearine.

Space does not allow us to pass in review the subsequent chapters, in which, however, we notice only one error of any moment. The use of cohesion figures as tests for the identity and purity of oils is here ascribed to Miss Kate Crane, with a reference to the *American Journal of Pharmacy* for September, 1874. If the author had referred to the Chemical News for 1868 (vol. xviii., pp. 249, 261, 272, and 299) he would have learnt that the process was devised by Mr. Tomlinson, and that Prof. Emerson Reynolds and Dr. Carter Moffat had been working at its development. It is nevertheless possible that Miss Crane's observations may have been made independently.

The work before us cannot be regarded as other than valuable and useful.

On Isodulcite.—MM. Rayman and Kruis.—Isodulcite has some analogies with arabinose, but it is not, as seemed probable, its methylic ether.—*Bull. Soc. Chim de Paris.*

CORRESPONDENCE.

COMBUSTION APPARATUS.

To the Editor of the Chemical News.

Sir,—Users of the combustion furnace are often annoyed by the breakage of their fire-clay tiles when accidentally let drop. I have found that asbestos card is far superior to the clay tiles, not being subject to this defect. Slabs of this may be cut to any size by using the broken point of some old knife. The material may be obtained, wholesale, in sheets of about 3×4 ft., as low as 4*d*. per lb. A better quality, however, is recommended, as this is very liable to flake.

Compared with the clay tiles it has the following advantages:—It is far lighter in weight; it does not absorb or transmit so much heat; hence the tube is kept hotter and the room cooler than with the ordinary tiles. It does not break when dropped about; it cools rapidly, so as to be quickly handled. It may be readily cut to any shape: this is especially useful when it is necessary to keep the flame from heating the ends of the tube; in such case a hole may easily be bored in a slab, and the end of the tube passed through this, so as to shut off the access of any flame.

In using iron tubes it is a nuisance to have to constantly replace the corks used for stopping the ends. These fit well at first, but getting dry they soon cease to be gas-tight. I get rid of corks now by having the end of the iron tube polished flat,—that is, at right angles to its length,—then screw on a brass cap, having a small eduction tube. This cap is turned true internally, so that a leaden washer may be inserted between the two plane surfaces, and by the screwing up of the cap may form a gas-tight joint. Of course the heat at the ends of the tubes is never sufficient to melt lead; were it so, the amount of carbon given off by a cork in the same situation would be enough to vitiate any analysis.—I am, &c.,

A. W. Stokes, F.C.S., F.I.C.,
Public Analyst, Paddington Vestry, W.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 12, March 19, 1888.

The Absorption of Saline Matters by Plants: Potassium Sulphate.—MM. Berthelot and André.—Plants draw their mineral elements from the soil, but the mechanism of this absorption is still obscure. Substances entirely insoluble can act only by contact with the roots, an action necessarily limited to narrow surfaces, whilst most of the reactions are exerted upon dilute solutions of the soluble matters which penetrate into the roots in conformity with the general laws of endosmose, dialysis, and capillarity. Hence there arise various chemical reactions of combination and of dissociation between the matters contained in the soil and the principles dissolved in the sap of the plant. These reactions cause certain compounds to penetrate into the roots; some of them identical with those already contained in the plants, others resulting from their decomposition, whilst other compounds are excreted and diffuse themselves in the surrounding soil. Potassium sulphate accumulates by preference in the leaves. Elsewhere it is found in a smaller proportion than that which would saturate a quantity of water equal to that contained in the plant. Such saturation does not appear compatible with the vitality of the plant.

The Relations of Atmospheric Nitrogen to Vegetable Mould.—Th. Schlœsing.—The author has shown that nitrogen, like oxygen, cannot undergo the least physical condensation in the soil regarded as a porous medium. He now takes up the question whether any chemical condensation can take place, the free gaseous nitrogen passing into combination? The mineral elements of the soil, if placed in contact with gaseous nitrogen for an indefinite time, remain indifferent to it, but the organic matter is still so little known that it might be supposed capable of fixing nitrogen. The author measured the gaseous nitrogen placed in contact with the soils for a prolonged time, and ascertained the variation or the permanence of its volume. The results of these experiments will be laid before the Academy on a future occasion.

Ultra-violet Band Spectrum of the Hydrogen and Oxygen Compounds of Carbon.—H. Deslandres.—This paper cannot be usefully reproduced without the accompanying diagram.

The Laws of Chemical Equilibrium. A Reply to H. Le Chatelier.—P. Duhem.—A controversial paper, not of general interest.

On Hydrated Hydrogen Sulphide.—MM. de Forcrand and Villard.—A re-determination of the vapour-tension of this compound.

A New Oxygen-acid of Sulphur.—A. Villiers.—The author has undertaken the study of the compounds which may result from the action of sulphur dioxide upon the thiosulphates. The author has obtained anhydrous crystals of the sodium salt of an acid, S_4O_8Na, and has subsequently produced them in combination with 2 mols. of water.

Action of Certain Oxides upon Dissolved Zinc and Manganese Chlorides.—G. André.—The author has examined the behaviour of zinc chloride with yellow mercury oxide, the product being a zinc oxychloride containing only 2·6 per cent of mercury. Zinc chloride with lead oxide yields a compound of zinc oxychloride with $ZnClPbO$.

On Diterebenthyl.—A. Renard.—An examination of the action of heat and of bromine upon this compound.

A Contribution to the Study of the Ptomaines.—Oechsner de Coninck.—A study of the basic products formed in the bacterian fermentation of Octopi. Two novel ptomaines have been discovered, $C_8H_{11}N$ and $C_{10}H_{11}N$.

Cyanogen Compounds of the Sulphines.—G. Patein.—The author gives a table of the sulphine-cyanines obtained.

Researches on the Fixation of Nitrogen by the Soil and by Plants.—Arm. Gautier and R. Drouin.—Soils containing no organic matter lost nitrogen in each of four series of experiments. Soils containing organic matter, on the contrary, were found capable of fixing nitrogen.

Moniteur Scientifique, Quesneville. Series 4, Vol. ii., January, 1888.

On Cadmium Sulphide, and on the Different Cadmium Yellows of Commerce.—G. Büechner (*Chemiker Zeitung*).—The finest pure colours are obtained by the action of hydrogen sulphide upon solutions of cadmium salts, and whatever their shade, they consist of cadmium sulphide in different physical conditions. Such colours are absolutely stable on exposure to light, and are consequently trustworthy as oil-colours. They are permanent on exposure to air, as none of the modifications of cadmium sulphide take up oxygen at common temperatures. Rancid oils, however, containing consequently free fatty acid, may darken light shades. Impure colours containing salts of cadmium soluble in water are to be rejected. The worst are those which contain finely-divided sulphur precipitated along with the cadmium sulphide. Such colours

fade very quickly on exposure to light. Arsenic, zinc, and iron sulphides are, of course, to be rejected if they exceed a few tenths per cent. All samples should be condemned which are mixed with cadmium hydroxide, hydrocarbonate, oxalate, or phosphate, as they are always changed by exposure to light. Sulphide containing hydroxide, if ground up with oil, takes a brownish colour on exposure to light. The most frequent adulterations are the addition of zinc oxide, carbonate, or sulphide, sometimes to the extent of 50 per cent. The sample ought to dissolve in hydrochloric acid, giving off hydrogen sulphide, and yielding a transparent or faintly opalescent liquid. Carbon disulphide should extract only slight traces of free sulphur. The hydrochloric solution diluted with water and saturated with hydrogen sulphide should give a yellow or orange precipitate, and the filtrate should not become turbid on the addition of ammonia or ammonium hydrosulphate. The hydrochloric solution should not be rendered turbid by an excess of ammonia nor by calcium chloride.

Studies on the Manufacture of Santonine.—A. Busch.—From the *Journal fur Praktische Chemie.*

Identity of the Photo-salts of Silver with the Matter of the Latent Photographic Image.—Carey Lea.—Translated from the Chemical News.

Industrial Review and Patents.—Under this title are given papers on the "Present Condition of the Leblanc Soda Works," on the "Fixation of Chrome by Wool," on "Electrolytic Bleaching Agents," on the "Determination of Impurities in Soaps," on the "Determination of Paratoluidine in Aniline for Red," on "Aromatic Hydroxylamines," on the "Detection of Saccharine," on "Wine Yeast," and abridged specifications of the following patents:—

Process for causticising lyes of alkaline carbonates in a vacuum. H. Herbert, of Barmen, H, No. 6981.

Improvement in platinising metals by electricity. B, No. 7389.

Process for purifying and preparing metallic surfaces intended to be coated with other metals, and for renewing metallic coatings by means of the electric current. M, No. 5171.

Improvement in the preparation of calcium and potassium tartrates. Th. Gladysz. G, No. 4244.

Preparation of aluminium with double fluorides of aluminium and barium, strontium, calcium, or zinc. A. Feldmann. F., No. 3320.

Preparation of soap dried at 100°. Brandt and Fude. B, No. 7895.

Desulphuration and purification of the petroleum hydrocarbons. D. M. Kennedy. K, No. 5513.

Preparation of a dextrine free from reducing sugar and capable of being substituted for gum arabic. A. Schuhmann. No. 4634.

Preparation of strontium hydroxide from the residues of (beet-root) treacle. L, No. 4441.

Transformation of camphor and menthone into borneol and menthol. Dr. Beckmann, B, No. 7554.

Preparation of methylene chloride. F, No. 5308.

Preparation of diphenyl-pyazolon and diphenyl-methyl-pyazolon by means of benzoyl-acetic ether and phenyl-hydrazin. F, No. 3340.

Preparation of a red azo-colour by means of alkaline naphthionates. W, No. 4827.

Preparation of a blue colouring-matter. F, No. 3274.

Preparation of a new naphthylamine monosulphonic acid. Casella and Co. No. 2206.

Preparation of α-pyridyl-acrylic and α-pyridyl-acetic acids. C. F. Boehringer and Sons. B, No. 7698.

Preparation of amido-diphenyl and amido-phenylen-naphthyl-acetones. F, No. 3328.

Preparation of β-naphthylamine γ- and δ-monosulphonic acids. Kinzelberger and Co. K, No. 5732.

Preparation of the reduction-products of meta-nitraniline or nitro-toluine and colouring-matters thence derived. Poirrier and Rosentiehl. P, No. 3385.

Preparation of azo-colours derived from tetrazo-diphenyl-ortho-disulphonic acid. A, No. 1556.

Preparation of alkylic azo-colours. Bayer and Co. F, No. 3070.

Red, violet, and violet-black azo-colours. P, No. 3416.

Preparation of reduced derivatives of nitrotoluidine and nitroxylidine. Poirrier and Rosentiehl. P, No. 3433.

Preparation of sulphur-derivatives of the para-diamines and manufacture of methylene blue. B, No. 7743.

Soluble Compounds of Phosphoric Acid in Superphosphates.—H. Otto.—In a superphosphate carefully prepared there were 49·90 per cent of P_2O_5. The total quantity of P_2O_5 found in a soluble state on lixiviating this product with small repeated quantities of water was 47·20. If 20 grms. of the sample were treated with 1000 c.c. of water the soluble phosphoric acid was only 45·8 per cent.

Determination of Reductive Sugars.—R. Geduldt.—This paper does not admit of useful abstraction.

Determination of Tannins.—H. M. Rau.—From the *Journal of the American Chemical Society.*

Société de Biologie.—Session December 17, 1887.

Treatment of Obesity.—M. Leven.—A purely medical paper.

Industrial Society of Mulhouse.—Session of November 9, 1887.—A sealed paper, deposited by M. St. De Kostanecki, and subsequently opened, was read. It is to this effect:—When a chromogene becomes a colouring-matter by the introduction of two hydroxyls or of the quinone oxime group (O.NOH), the colouring-matter has the power of dyeing mordanted fibres only when the two groups in question are in the ortho-position.

M. Fourneaux sent in a memoir on alkaline discharges upon alizarin reds. Whites are got with caustic soda, blues with soda, alizarin blue, Nicholson blue, and benzazurin, yellows with caustic soda and chrysamine. All the colours are thickened with a mixture of British gum and tragacanth. After printing the pieces are steamed without pressure, passed into vitriol sours and washed.

M. Meyer read a note on the use of Indian gums as thickeners. He succeeds in using them by boiling under pressure in a steam jacketted pan. They are then preferable to gum senegal. The author finds British gum improved by boiling under pressure with the addition of 1 per cent of caustic lime.

Memoir of Gustav Kirchoff.—An address by Prof. Hofmann.

Fractionated Reduction of Ortho- and Paratoluene.—MM. Miniati, Booth and Cohen.—From *Journal of the Society of Chemical Industry.*

The Effects of Small Quantities of Bismuth upon the Ductility of Silver.—J. Scully.—From the Chemical News.

Bulletin de la Société Chimique de Paris.
Vol. xlviii., No. 10, November 20, 1887.

Homologues of Acetyl-acetone; General Methods for the Preparation of a Series of Diacetones, Simple Acetones, and of their Derivatives.—Alph. Combes.

New Syntheses in the Fatty Series by Means of Aluminium Chloride.—Alph. Combes.—These two papers are a continuation of those by the same author in Nos. 8 and 9.

The Action of Chlorine upon the Sulphides of the Alcohol Radicles; Preparation of Some Novel Chlorine Derivatives.—W. Spring and A. Lecrenier.—From the facts observed by the authors it follows that the hydrocarbon groups C_nH_{2n+1} behave with chlorine differently if combined with sulphur from when, combined with hydrogen, they form part of the hydrocarbons properly so-called. The latter, when treated with chlorine, yield chlorine derivatives in which the atoms of the non-metal

are distributed with less regularity. When the groups $C_nH_{2n}+1$ have been combined with sulphur the chlorine seems concentrated by preference around the atom of carbon originally united to the sulphur, invading the mol. successively, so as not to seize another atom of carbon until the affinities of the first are saturated.

The Constitution of Guthrie's Chlorised Ethyl Disulphide.—W. Spring and A. Lecrenier.—Guthrie's reaction takes place in the normal manner without any change in the position of the atoms in the molecule.

Observation on the Subject of a Memoir by Mr. W. Hallock, entitled "The Flow of Solids."—W. Spring.—The author shows that Mr. Hallock has completely misunderstood his results, and has refuted it from that point of view.

A New Method of Forming the Substituted Saffranines.—MM. Barbier and Leo Vignon.—The authors have experimented on the action of para-nitroso-dimethyl-aniline hydrochlorate upon aniline and ortho-toluidine dissolved in alcohol of 92 per cent, and in a reflux-apparatus.

The Volatile Acids of Suint.—A. Buisine.—The acids in question are the formic, acetic, propionic, butyric, valerianic, caproic, caprylic, benzoic, and phenol.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Analysis of a Mixture.—Will any of your correspondents kindly let me know where I can see a method of analysing a mixture of potassic nitrate, sodic nitrate, potassic chloride, and sodic chloride? Of course it is simple enough to estimate the bases and the nitric and hydrochloric acids (chlorine), but what I want is to find out the proportion of each substance in the mixture:—KNO_3, $NaNO_3$, KCl, and NaCl.—Alfred Luck.

MEETINGS FOR THE WEEK.

Monday, 16th.—Medical, 8.30.
— Society of Arts, 8. "Milk Supply, and Butter and Cheese Making," by Richard Bannister, F.I.C., F.C.S.
Tuesday, 17th.—Institution of Civil Engineers, 8.
— Pathological, 8.30.
— Royal Institution, 3. "John Ruskin," by Charles Waldstein, Ph.D.
— Society of Arts, 8. "A Hundred Years' Progress in New South Wales," by W. F. Buchanan, J.P.
Wednesday, 18th.—Meteorological, 7.
— Society of Arts, 8. Telescopes for Stellar Photography," by Sir Howard Grubb, F.R.S.
Thursday, 19th.—Royal, 4.30.
— Royal Society Club, 6.30.
— Royal Institution, 3. "The Chemical Arts," by Professor Dewar, M.A., F.R.S.
— Parkes Museum, 5. "The Public Health in India," by Mr. Justice Cunningham.
— Chemical, 8 Ballot for the Election of Fellows. "The Influence of Temperature on the Composition and Solubility of Hydrated Calcium Sulphate and of Calcium Hydroxide," by W. A. Shenstone and J. T. Cundall.
Friday, 20th.—Royal Institution, 9. "Antagonism," by the Right Hon. Sir William R. Grove, M.A., D.C.L., LL.D., F.R.S.
Saturday, 21st.—Royal Institution, 3. "The Later Works of Richard Wagner," by Carl Armbruster.

TO CORRESPONDENTS.

The Institute of Chemistry.—We have received a very large number of letters on matters connected with the Institute of Chemistry, including one from Mr. W. Thomson, Royal Institution, Manchester, replying to the statements made in the letters of Mr. Friswell and "One who was There." Were we to insert all the letters sent to us on this subject, the Chemical News would contain nothing else for several weeks, and the majority of our readers would have just cause to complain that their interests were sacrificed for the sake of a personal controversy only interesting to a few. For this reason we must decline to allow further space to be taken up in the discussion of the Institute's affairs.—[Ed. *C. N.*]

LABORATORY TO LET, near City.—Three Floors Well suited for Analytical or for Experimental and Research Work. Steam Boiler and Engine. Rent £40.—Address, Box 367, Chemical News Office, Boy Court, Ludgate Hill, London, E.C.

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PATENTS, DESIGNS, & TRADE MARKS ACT, 1883.

In the matter of Letters Patent granted to Thomas Gilbert Bowick, of Harpenden, in the County of Herts, for "An improved process and apparatus for purifying alcohols by means of hydrocarbons," dated the 29th October, 1887, No. 14737.

NOTICE IS HEREBY GIVEN that the said T. G. Bowick has applied for leave to amend the specification numbered as above.

A copy of the Specification as proposed to be amended can be inspected at the Patent Office, and full particulars of the proposed amendment were set forth in the Official Journal of the Patent Office issued on the 7th of April, 1888.

Any person intending to oppose the said application must leave particulars of his objections thereto (on Form G) at the Patent Office, 25, Southampton Buildings, London, W.C., within one calendar month from the date hereof.

Dated this 7th day of April, 1888.

(Signed) H. READER LACK, Comptroller-General.

ABEL AND IMRAY, Agents for the Applicant, 28, Southampton Buildings, London, W.C.

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MEXICO AND THE PACIFIC STATES.

PROF. A. E. FOOTE,

Of 1223, Belmont Ave., Phila., Pa., U.S.A.,

Is about to start on his third trip to Mexico, the Pacific Slope, and the Rocky Mountain region. A familiarity with the Spanish language and experience in Mexican mines will render his services especially valuable to those desiring reliable information.

THE CHEMICAL NEWS.

Vol. LVII. No. 1482.

THE INFLUENCE OF PHOSPHORUS ON THE ESTIMATION OF CHROMIUM IN IRON OR STEEL.

By J. O. ARNOLD and HENRY J. HARDY.

In the Chemical News (vol. xlii., p. 285) a process for the estimation of chromium in iron and steel was published by one of us. That method, although sufficiently accurate for materials low in phosphorus, is not reliable when the metalloid is abnormally high. The error arises from the fact that in such cases the final precipitate consists not of chromic oxide, but of a mixture of oxide and phosphate, or possibly of a phosphate only. The cause of such effect is that when steel or iron is dissolved in hydrochloric acid, and evaporated to dryness, a portion of its phosphorus is evolved as hydride, whilst some remains as phosphate. The question whether or not this behaviour arises from the existence of phosphorus in more than one form in the metal is not connected with the present subject.

To indicate the amount of the residual oxidised phosphorus, and its effect on the estimation of chromium, two steels and a pig-iron were made, which on analysis gave the following results:—

No.	Material.	Phosphorus, p. c.	Chromium. p. c.
1.	Steel	0·064	0·31
2.	,,	0·204	0·33
3.	Grey iron	1·080	1·18

(The phosphorus was estimated by the modification of the combined molybdate and magnesia methods published by one of us in the Chemical News, vol. xliii., p. 147, The chromium was determined by the process hereinafter detailed.)

Two grms. of each metal were next dissolved in 20 c.c. fuming hydrochloric acid, and evaporated to dryness. The residue was fused with a mixture of sodium carbonate and potassium nitrate, extracted with water, acidified with HCl, and made faintly alkaline with ammonia. The P_2O_5 was then estimated in the resulting precipitates. Results:—

No. 1.	Grm. P_2O_5	0·0006
2.	,, ...	0·0023
3.	,, ...	0·0202

These weights would produce the following errors on weighing the precipitate as oxide:—

No. 1.	Error ..	0·03 chromium per cent high.	
2.	,, ..	0·09	,, ,,
3.	,, ..	0·74	,, ,,

In a useful little handbook on Iron and Steel Analysis written by Mr. Thomas Bayley, the author by some oversight adopts the course of dissolving the material in which the chromium is about to be estimated in *aqua regia*, thus oxidising practically the whole of the phosphorus, and then weighs the precipitate as oxide. This procedure will obviously ensure a sensible inaccuracy even in a steel low in phosphorus. Thus, taking the case of No. 1 steel. which contains 0·064 per cent of phosphorus and 0·31 per cent of chromium, the result would be registered as 0·41 per cent of chromium, or over 30 per cent high.

Again, Mr. Bayley evaporates the solution in *aqua regia* to dryness, filters off the silica, and estimates the chromium in the filtrate. This in the case of a rich chrome iron is a fatal proceeding, because with the silica will be found an insoluble metallic residue high in chromium.* Thus a chrome pig iron containing 0·072 per cent of phosphorus and 9·83 per cent of chromium gave, by Mr. Bayley's process, only 7·38 per cent of chromium, or only 75 per cent of the metal really present.

It is therefore very necessary, in estimating high chromium in iron and steel, that the whole of the residue, as well as the products of solution, should be submitted to fusion.

Since the introduction of the Basic process, phosphoric irons and (this in a whisper) steels are more frequently dealt with by the steel analyst than formerly, and from what has been stated it will be evident that the results obtained in estimating chromium as oxide in such materials are quite untrustworthy. The authors therefore came to the conclusion that the easiest way out of the difficulty would be to obtain a definite phosphate precipitate, under which condition the presence of more or less phosphorus in the steel, or of a small quantity in the reagents used during the analysis, would become a matter of indifference.

As a preliminary step various weights of pure dry potassium bichromate were reduced in a hydrochloric acid solution by means of sulphurous acid. The chromium was then precipitated by a faint excess of ammonia in the presence of varying amounts of phosphoric acid introduced by means of a solution of sodium phosphate carefully standardised by magnesia.

The results tabulated below show that in the presence of the theoretical amount, or of a moderate excess of P_2O_5, chromic oxide is completely precipitated on digestion with a slight excess of ammonia as a basic phosphate, $Cr_6P_4O_{19}=3Cr_2O_3.2P_2O_5$, whilst in the presence of a large excess of P_2O_5 the precipitate is uncertain in composition, being sometimes the normal phosphate $Cr_2P_2O_8=Cr_2O_3.P_2O_5$, sometimes a mixture of normal and basic salt, and sometimes a mixture of normal and acid phosphate.

Table I.—(Grammes).

Cr_2O_3.	P_2O_5.	Precipitate.	Theory $Cr_6P_4O_{19}$.	Theory $Cr_2P_2O_8$.
0·0265	0·0221	0·0430	0·0430	—
0·0258	0·0221	0·0415	0·0418	—
0·0516	0·0387	0·0830	0·0837	—
0·0258	0·0600	0·0500	—	0·0500
*0·0546	0·0800	0·0990	0·0885	0·1056

Table II.

Ratio of Molecules.		Grammes.				
Cr_2O_3.	P_2O_5.	Cr_2O_3.	P_2O_5.	Precipitate*	Theory $Cr_6P_4O_{19}$.	Theory $Cr_2P_2O_8$.
3	2	0·0389	0·0240	0·0625	0·0629	—
1	1	0·0258	0·0240	0·0420	0·0417	—
†1	16	0·0258	0·3840	0·0560	0·0417	0·0500
1	32	0·0258	0·7680	0·0496	—	0·0500

Two quantities of potassium bichromate, weighing respectively 0·1000 and 0·1064 grm., were reduced by sulphurous acid in an hydrochloric acid solution, and precipitated with ammonia in the presence of excess of sodium phosphate. The indefinite phosphates thus obtained were dissolved in hydrochloric acid and re-precipitated by ammonia.

In these precipitates, after thorough washing, the phosphoric acid was determined — No. 1 by magnesia after precipitation with ammonium molybdate, No. 2 by molybdate alone. Results:—

No.	P_2O_5.	
	Theory $Cr_6P_4O_{19}$.	Found.
1.	0·0317	0·0312
2.	0·0350	0·0348

In estimation No. 1, 1·5 m.grms. was added to the

* This residue is usually practically free from phosphorus.

* Indefinite basic phosphate.
† Indefinite acid phosphate.

weight of pyrophosphate obtained as correction for solubility.

From the foregoing tables it is obvious that under suitable conditions chromium is readily obtained as a basic phosphate of invariable composition. This compound has a great advantage over the hydrate in the fact that, unlike the latter, it has little inclination to abstract silica from glass vessels; therefore the precipitation may be carried out with safety in a convenient beaker, instead of in the somewhat cumbersome porcelain basin usually deemed necessary when precipitating chromium as hydrate with ammonia.

The manipulation of the new process differs but little from that of the method published in 1880; but as the accuracy of the results depends upon a rigid adherence to detail, the exact *modus operandi* is again set forth, embodying, however, one or two alterations which extended experience has shown to be convenient.

Method.

In the case of steel about 2 grms. of drillings may be taken for analysis. (When the material under examination is a chrome pig-iron, or other rich alloy, about 0·5 grm. in *fine* powder will suffice.) The metal is dissolved in 20 c.c. of fuming hydrochloric acid,* and the solution is gently evaporated to dryness, so that the brittle cake of chlorides is readily detached from the bottom of the beaker. The mass is broken up with a spatula and brushed into a porcelain dish; the small portion adhering to the beaker is treated with 2 or 3 c.c. of hot hydrochloric acid; then by means of a "policeman" every particle of insoluble residue is detached from the glass, rinsed into a deep platinum basin, and the whole is evaporated to dryness. Whilst the evaporation is proceeding the main residue is carefully crushed to a *fine* powder in the porcelain dish, by means of a small glass pestle. The powder is added to the dry residue in the platinum basin, both dish and pestle being carefully cleaned.

The chlorides are next *intimately* mixed with not less than five times their weight of a fusion mixture composed of equal parts of dry sodium carbonate and powdered potassium nitrate; a cover is placed on the basin, and the contents of the latter are fused, cautiously at first, over a powerful Bunsen flame for at least fifteen minutes. When somewhat cool the cover is removed, and any splashings upon it are washed into a beaker containing 100 c.c. of boiling water, in which the basin containing the fusion is stirred and heated until the insoluble oxide of iron is completely detached. The dish is then carefully washed and removed.

The beaker is heated for half an hour nearly to boiling; any alkaline manganate present will be thus completely decomposed, and the oxide precipitated, the addition of alcohol as a reducing agent being quite unnecessary.

In order to save time, and to do away with the well-known difficulty of washing the finely-divided ferric oxide without causing some of it to pass into the filtrate, the authors have devised the following plan:—At the commencement of the analysis exactly 2·4 grms. of metal are weighed out, the extract and residue from the fusion are carefully transferred to a graduated flask (marked in the neck to contain 301 c.c.), diluted to the mark with warm water, and the temperature carefully noted, the homogeneity of the liquid being first ensured. When the oxides have nearly settled, about 250 c.c. are filtered off through a *dry*, *double* filter, into a ¼ litre flask marked in the neck; the liquid is again brought to its original temperature, and is then adjusted to the mark by means of a pipette: the 250 c.c. of clear liquid thus obtained contains the chromium present in 2 grms. of steel.†

The yellow chromate solution is placed in a covered beaker and acidified with about 20 c.c. of hydrochloric acid, and is then boiled. No alcohol is required to reduce the anhydride to oxide, the nitrous gas liberated from the nitrite resulting from the fusion effectually deoxidises the chromate. (The use of alcohol is very objectionable: the resulting aldehyd, &c., is not easily got rid of by boiling, and its presence tends to prevent the complete precipitation of the chromium.) At this stage excess of ordinary sodium phosphate solution must be added (say 10 c.c. of a 10 per cent solution). The phosphate is now precipitated by means of dilute ammonia, added in the smallest possible excess. The liquid is digested nearly at boiling-point till bright and colourless. The precipitate is filtered off (it need not be washed), and is then dissolved off the filter with hot hydrochloric acid into the beaker in which the precipitation took place. The filter is well washed with cold water, and is set aside under cover for use in separating the silica. The bright green solution is boiled down, and finally very cautiously evaporated to dryness. The phosphate is taken up by *boiling* with a few c.c. of hydrochloric acid, and the insoluble residue filtered off. The filter is exhaustively washed, and the filtrate, diluted to about 200 c.c., is heated nearly to boiling and treated with diluted ammonia to slight alkalinity. It is digested as before, the phosphate filtered off, *gently* washed with hot water (a too vigorous use of the wash-bottle may cause the precipitate to pass into the filtrate to some slight extent), dried, ignited, and weighed as $Cr_6P_4O_{19}$, containing 42·48 per cent of metal.

The exactness of the process, in spite of the somewhat prolonged manipulation, is indicated by the following experiments:—

Two quantities of steel, proved free from chromium, were taken: (1) 1·9646 grms., (2) 1·9965 grms. To No. 1 0·1000 grm. of potassium bichromate was added, and to No. 2 0·0100 of the bichromate. Results:—

No.	Gramme Chromium.	
	Theory.	Found.
1.	0·0354	0·0351
2.	0·0035	0·0035

As a check on the constitution $3Cr_2O_3.2P_2O_5$ the above precipitates were re-fused, extracted with water, acidified with hydrochloric acid, a little ferric chloride being also added, and the whole precipitated with a faint excess of ammonia. The resulting precipitate was dissolved in hydrochloric acid, evaporated to very low bulk, and again thrown down with excess of ammonia. Excess of strong nitric acid was next added, and whilst boiling a large excess of ammonium molybdate. The resulting yellow salt was well washed with dilute nitric acid, dissolved in ammonia, and the P_2O_5 was precipitated with magnesia mixture in the respective volumes of 30 and 15 c.c. The pyrophosphate was obtained with the usual precautions, no correction, however, being made for solubility. Results:—

No.	Gramme P_2O_5.	
	Theory.	Found.
1.	0·0319	0·0314
2.	0·0030	0·0027

By the present process the chromium in iron products can be estimated with great accuracy. It provides for the removal of all elements at all likely to be present, viz., carbon, silicon, sulphur, manganese, tungsten, and copper, whilst the elements rarely present or stated to be

* Sulphuric, nitric, and nitro-hydrochloric acids will be found in practice to be highly inconvenient solvents.

† This operation is based on the following approximate data:—An average steel is taken as containing 99·25 per cent of iron and manganese; consequently the oxide resulting from such a metal will weigh 3·4 grms.: its specific gravity has been found by experiment to be 4·13; it will therefore occupy nearly 1 c.c. Thus the total volume, 301 c.c., is the bulk occupied by the oxide plus 300 c.c. containing in solution the chromium of 2·4 grms. of steel; therefore five-sixths of this fluid will contain the chromium of 2 grms. of steel: the necessity for coincident temperatures is too obvious to require explanation. When only 0·5 grm. of material is taken, the correction for the volume of the oxide may be dispensed with without sensible error.

present in steel, viz., arsenic, titanium, and aluminium,* also do not affect the result.

It is a matter of indifference whether or not the metal is soluble or only partially soluble in the acid, though in the latter case it is advisable to prolong the fusion.

As far as the authors' knowledge goes the foregoing is the only published method applicable with propriety to every class of chrome alloys and steels.

It was suggested to them that the volumetric process sometimes applied directly to chrome metals (in which chromic salts in sulphuric acid solution are oxidised by potassium permanganate to chromates, a known quantity in excess of a ferrous salt being then added and the excess of ferrous iron determined by titrating backwards with potassium bichromate) might be applied to the precipitate of hydrate or phosphate obtained after the fusion, but experience has shown that this method is unreliable, the results being frequently low, sometimes very seriously so.

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PRESSURE TUBES, THEIR USE, AND CONSTRUCTION.

By H. N. WARREN, Research Analyst.

The common pressure tube, generally consisting of a piece of stout glass combustion-tubing which has been accurately sealed at either extremity, and enclosing the substance to be operated upon, is altogether too well known to need description. But in order to keep pace with scientific investigations intense pressure is often a very desirable agent to the chemist when operating on various substances, and of all substances used for the construction of the same no substance answers the purpose more admirably than that of glass, both on account of the ease with which it may be broken and its contents examined at the termination of the reaction, and the less danger of contaminating the contents with impurities than when iron, or even platinum, is used; but although even the best quality combustion-tubing, when properly sealed, will stand an intense pressure at all normal temperatures, yet, at the lowest red heat, the glass quickly begins to expand, and the tube ultimately bursts, and for the prevention of which I have used, with great success, tubes of the following construction, and intended for temperatures ranging from 400° to 700° F.

The substance for examination is first enclosed in an ordinary combustion-tube, and accurately sealed at both ends. A copper tube is next selected about two inches longer than the glass tube, and allowing of about ¼ of an inch dimension to intervene between the outside of the glass tube and the inside of the copper one. The space between the two tubes is next carefully filled in with perfectly dry magnesia, and commenced by screwing on one of the caps, with which the tube should be provided, the MgO being introduced until it protrudes slightly beyond the inside of the screw cap: the glass tube is now inserted by gently pressing, and the magnesia gradually added by small quantities at a time, until the space is entirely filled in, the tube being well tapped to ensure accurate packing of the magnesia, after each fresh addition. The tube should now, if successfully packed, be perfectly firm, and remain so on shaking. A second screw cap having been previously filled with the magnesia is next screwed over the other extremity, and the tube and its contents are introduced into a bath containing molten lead, and maintained at the desired temperature.

Excellent results may be obtained by this method, among which may be mentioned the decomposition of siliceous slags when in contact with H_2SO_4, the decomposition of fire-clay, which may be entirely decomposed in the course of an hour, and the Al_2O_3 estimated, which by any ordinary method usually takes from eight to ten hours. For higher temperatures where a red heat is desired, the outer tube should consist of wrought-iron, and fine sand substituted for the magnesia. By means of a tube constructed on this principle I have frequently maintained sulphur at a red heat for some hours, and caused a weighed quantity of the same to combine exactly with an equivalent quantity of metallic copper; I may also mention that out of a number of tubes that I have constructed by this process only two have burst; it is of course unnecessary to add that great care should be used during the reaction.

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* If this element is present it is perhaps advisable to add ammonium bicarbonate after extracting the fusion.

ON THE RANGE OF MOLECULAR FORCES.*

By A. W. RÜCKER, M.A., F.R.S.

(Concluded from p. 147).

The value of v obtained by Exner are remarkably confirmed by those deduced from the theory of Van der Waals. In the general relation between pressure, volume, and temperature, given by him, a constant b occurs which is, according to Van der Waals, $=4v$, and, according to O. Meyer, $=4\sqrt{2v}$.

The value of b may be obtained in several ways. Meyer deduces it from a comparison between the terms of Van der Waals's formula and the constants of a similar empirical formula of Regnault's. The values so obtained are of the same order as those given by other methods, but I do not think that Meyer's plan is as satisfactory as those adopted by Van der Waals himself, as it largely depends on the value of a very small constant in the empirical formula.

Van der Waals makes two comparisons—the one with Regnault's observation (*Die Continuität*, &c., 73 to 79) and the other with Cailletet's results (*loc. cit.*, 98 and 99), and he shows that the constants obtained by the former method produce a fair agreement with the observations of Andrews (*loc. cit.*, 80).

The table is obtained by taking these results (comp. Meyer, *Kinetische Theorie*, 75) and reducing all values to the standard pressure of one atmosphere.

	Value of b from—			Value of v according to—	
	Regnault.	Cailletet.	Mean value of b.	Van der Waals, $b=4v$.	O. Meyer $b=4\sqrt{2v}$.
Air ..	0·00195	—	0·00195	0·00049	0·00035
H_2 ..	0·00049	0·00050	0·00050	0·00012	0·000088
CO_2 ..	0·0023	—	0·0023	0·00057	0·00041

The value of b for SO_2 deduced from experiments by Cagniard de la Tour is 0·0032, which leads to $v=0·0006$ according to Meyer's formula. As these early observations were probably not so accurate as the others we are discussing, I shall not make use of his results, also as Meyer's relation between b and v appears to be the best, I shall hereafter employ it only.

Before discussing this table further I must point out that there are some slight errors in the books which deal with the subject, and which account for discrepancies between the figures as given by others and by myself. The numerical value of b which is proportional to the ratio of the volume of the molecules to the volume of the gas under standard conditions, increases with the standard pressure, and may be taken as proportional to it.

The values obtained by Van der Waals from Regnault and Cailletet's results are referred to pressures of 1 m. and 760 m.m. respectively. Ruhlmann (*Mechanische Warmetheorie*, ii., 244, Vieweg und Sohn, 1885) reduces them all to a pressure of 1 metre, but in so doing he

* A Lecture delivered before the Chemical Society, Feb. 2, 1888.

multiplies the numbers which are referred to an atmosphere by 0·76 instead of dividing. Thus, as corresponding to 0·00198, he gives 0·0015, and so on. By this mistake he conceals the practical identity of the values obtained by Van der Waals.

O. Meyer himself makes a similar mistake. The value of b for CO_2 referred to a pressure of 1 m. is 0·003 (*Die Continuität*, &c., 74). Van der Waals calculates it for 1 atmosphere on p. 80, and finds $b = 0·0023$. Yet Meyer (*Kinetische Theorie*, 231) treats this value as though it referred to the larger pressure, and finds that for CO_2 $d = 0·18$ $\mu.\mu.$ instead of 0·23 $\mu.\mu.$, which is the correct value deduced from his other data. I point out these errors only to prevent confusion on the part of those who might happen to compare the different tables of values.

In the next table are the values of v obtained from the specific inductive capacity, the refractive index, and the theory of Van der Waals.

Table of Values of v.

	Calculated from K, as determined by—			
	Boltzmann, $10^{-5}\times$	Klemencic, $10^{-5}\times$	Calculated from n, Mascart, $10^{-5}\times$	Calculated from b, Van der Waals and O. Meyer, $10^{-5}\times$
Air ..	20	20	20	35
H_2 ..	8·8	8·8	9·3	8·8
CO_2 ..	32	33	30	41

Without laying stress on the extraordinary similarity between the values of v obtained in the case of H_2 from the dynamical theory of gases, and from electrical and optical formulæ, I think that the agreement as to the order of the magnitudes of v calculated by such various methods is very strong evidence that they are approximately correct. It will also be observed that they are intermediate in value to the superior and inferior limits given by Loschmidt and Sir William Thomson respectively.

Loschmidt regarded the liquid as formed of molecules in contact, an assumption which could not give too small a value for v; Sir W. Thomson selects a condensation coefficient, which he is sure is not large enough. We thus get in the case of air—

Superior limit (Loschmidt)	86	$\times 10^{-5}$
Actual value calculated from b.. ..	35	$\times 10^{-5}$
,, ,, ,, n.. ..	20	$\times 10^{-5}$
,, ,, ,, K.. ..	20	$\times 10^{-5}$
Inferior limit (Sir W. Thomson) ..	2·5	$\times 10^{-5}$

We may, therefore, conclude that the space occupied in the sense previously defined by the molecules in air at 0° C. and 760 m.m. is about one five-thousanth (0·0002) of the volume of the gas. As Loschmidt's calculation is based on the assumption that in a liquid $v = 1/1·17 = 0·85$, and as Exner's value in the above table is 20/86 of his, it follows that in liquid air the value of v would be about 0·2. Very similar values are obtained for substances which can be liquefied easily. Thus the observed value of v for water vapour is 0·00017. This is referred to 0° C. and 760. But at 0° C. and 4·6 m.m. (the maximum tension of aqueous vapour at that temperature), the volume of saturated steam is 210,660 times the volume of the liquid. Under standard conditions this would be reduced to $210{,}660 \times 4·6/760 = 1275$.

Hence for liquid water $v = 0·00017 \times 1275 = 0·22$. We conclude that in liquids about one-fifth only of the total volume is filled with matter, which is in accord with the numbers before obtained from Hopkinson's results.

To calculate the diameter of a molecule we must know not only v but also L. This may also be determined by three independent methods of experiment, viz., by the determination of the coefficients of viscosity, diffusion, and thermal conductivity. As the values of the coefficient of viscosity given by Meyer are not reduced to 0° C., I take the values of L deduced from these given by Ruhlmann (*Mechanische Warmetheorie*, 227). For those which depend on diffusion I quote Stefan's deductions from Loschmidt's experiments as given by Exner (*loc. cit.*, 450). Taking the coefficients of thermal conductivity determined by experiment by Kundt and Warburg, Winklemann and Stefan, as given by O. Meyer (*loc. cit.* 194). I have calculated back to the coefficients of viscosity by the formula $k = 1·53\eta c$, where k and η are the coefficients of conductivity and viscosity, and c is the specific heat at constant volume, and have then deduced L from the coefficient of viscosity thus calculated. The results are given in the following table, and prove that there is at a events no doubt as to the order of the magnitude of L.

Values of L.

	L in $\mu.\mu.$ calculated from—		
Substance.	Viscosity.	Diffusion.	Thermal conductivity.
Air	99	71	110
H_2	194	139	186
CO_2	66	50	55
CO	97	65	106
N_2O	66	42	59

We are now, if the various theoretical assumptions are allowed, in a position to calculate the diameter of a molecule of air, H_2, or CO_2, by three absolutely independent methods. We may combine the values of v obtained from the specific inductive capacity, the refractive index, and the theory of Van der Waals, with the values of L deduced from the coefficients of viscosity, diffusion, and thermal conductivity, respectively. The results are shown in the following table:—

	Diameter of gaseous molecule in $\mu.\mu.$ calculated from—		
Substance.	Specific inductive capacity and viscosity.	Refractive index and diffusion.	Expansion and thermal conductivity.
Air	0·17	0·12	0·33
H_2	0·14	0·11	0·14
CO_2	0·18	0·13	0·19

Without insisting too much on an agreement which can be exemplified in the case of a few gases only, and which would probably not be exhibited by the results of experiments on vapours, it is not too much to say that it cannot possibly be fortuitous, and that it leaves very little doubt that the so-called diameter of a gaseous molecule is of the same order of magnitude as 0·2 $\mu.\mu.$

In conclusion, I think it may be well to attempt to class the phenomena which have been observed in very thin layers of matter, and the results of calculations on the size of moleucles, in the order of the magnitudes involved. It is probable that such a statement will have to undergo much correction in the future, but it may be useful and suggestive in the present. At all events, I think it will show that the time has passed when any estimate, however rough, as to the magnitude of molecules or of the radius of molecular action is to be welcomed. We know now what the order of these magnitudes is, and observations are wanted, based on reliable methods, and leading to definite results.

In drawing up such a table I shall, therefore, reject measurements which appear to me to be open to very grave doubt.

In the first place all results as to the condensation of liquid films on solids which lead to values of the radius of molecular action of several hundred or even several thousand micromillimetres must be rejected until they are confirmed by other methods. The *onus* of proving that the bodies used are not porous, not absorbent, and not affected with impurities which can unite chemically with, or dissolve in, water, lies with the investigators who adopt this method. Not only have the observations on agate, varnished metals, and glass, shown that these are grave and probable sources of error, but Ihmori has proved that when they are as far as possible got rid of the thickness of the condensed film is very small. The fact that soap

films exhibit no trace of change in their surface-tension or other properties till a thickness of about 50 $\mu.\mu.$ is reached, makes it absolutely incredible that the radius of molecular attraction should have a magnitude of from 500 to 3000 $\mu.\mu.$ In this view I am supported by the opinion of Sir W. Thomson, who has laid it down as "quite certain that the molecular attraction does not become sensible until the distance is much less than 250 micromillimetres" (*Proc. Roy. Inst.*, xi., Part III., 415, 1887).

Important, too, as the observations of Ihmori and Warburg are, I do not think that they can be used for our present purpose. They refer only to the temporary film, and therefore do not afford direct information as to the distance between the surface of the glass and the outermost water layer. This is given by Bunsen's observations, though it is doubtful what the nature of the attraction by which the water is held may be.

I shall also reject calculations based on the polarisation produced by gases. The uncertainty as to the density of the films deprives these estimates of all value. The same objection does not, however, apply to measurements of the thickness of the electrical double layer. I shall, therefore, include these and the results of observations on the polarisation of metal by metal, subject of course, to the criticisms which I have already made. I include Plateau's results on account of their historical interest.

Tables of Properties of Thin Films and of Molecular Magnitudes.

118 $\mu.\mu.$

Superior limit to the radius of molecular action, deduced from Plateau's experiments on the pressure of a soap bubble by Maxwell's theory that the surface tension first diminishes when the thickness of the film $= \rho$.

96—45 $\mu.\mu.$

Between these limits the thickness of a film begins to be unstable, *i.e.*, the surface-tension begins to diminish. Hence the radius of molecular action must be $<$ 96 $\mu.\mu.$, and $>$ 22 $\mu.\mu.$

59 $\mu.\mu.$

Superior limit to ρ deduced by Plateau on the assumption that the surface-tension first diminishes when the thickness $= 2\rho$.

50 $\mu.\mu.$

Value of ρ deduced by Quincke from experiments on capillary elevation. Hence the thickness should begin to be unstable when it is 100 $\mu.\mu.$ or 50 $\mu.\mu.$, according as we adopt Plateau's or Maxwell's views. Probably the truth lies between the two. There is therefore a remarkable accord between Quincke's result and the superior limits to the unstable thickness (96—45) obtained by Reinold and Rücker from experiment.

12 $\mu.\mu.$

Average thickness of black soap films measured by two independent methods. As the tension of a black film is equal to that of a thick film, the surface-tension, which begins to diminish at 50 $\mu.\mu.$, must increase again and reach its original value at 12 $\mu.\mu.$ The fact that each black film is of uniform thickness proves that the surface-tension is still increasing at 12 $\mu.\mu.$, which is the lower limit to the range of unstable thickness. This is also about the thickness below which, according to O. Wiener, a thin silver plate will no longer produce the same effect on the phase of reflected light as a thick silver plate would do.

10·5 $\mu.\mu.$

Thickness of the permanent water film observed by Bunsen on unwashed glass at a temperature (23° C.) at which the vapour pressure of water is small.

4 $\mu.\mu.$ to 3 $\mu.\mu.$

Average distance from centre to nearest centre of molecules in gases under standard conditions calculated by Meyer. If Exner's values of v be accepted, the distance would be more nearly 2 $\mu\,\mu.$

3 $\mu.\mu.$ to 1 $\mu\,\mu.$

Thickness of metal films required to polarise platinum completely according to Oberbeck.

1 $\mu.\mu.$ to 0·02 $\mu.\mu.$

Thickness of electric double layer according to Oberbeck and Falck. Lippmann found 0·3 $\mu.\mu.$

0·2 $\mu.\mu.$

Smallest thickness of silver which affects the phase of reflected light.

0·14 to 0·11 $\mu.\mu.$

Diameter of gaseous hydrogen molecule as given by combining—

(1.) The specific inductive capacity and coefficient of viscosity.

(2.) The refractive index and coefficient of diffusion.

(3.) The law of expansion and the thermal conductivity.

0·07 to 0·02 $\mu.\mu.$

Average distance between centres of molecules supposed arranged uniformly in liquids and solids according to Thomson. A superior limit found by L. Lorenz was 0·1 $\mu.\mu.$

0·02 $\mu.\mu.$

Inferior limit to the diameter of a gaseous molecule according to Thomson.

These results may be shortly summed up as follows:—

$\mu.\mu.$		
118	Superior limit to ρ	Plateau. (Maxwell).
96—45	Range of unstable thickness begins	Reinold and Rücker.
59	Superior limit to ρ	Plateau.
50	Magnitude of ρ	Quincke.
12	Range of unstable thickness ends	Reinold and Rücker.
12	Action of silver plate on phase of reflected light alters..	Wiener.
10·5	Thickness of permanent water film on glass at 23° C.	Bunsen.
4—3	Mean distance between centres of nearest molecules in gases at 760 m.m. and 0° C.	O. Meyer.
3—1	Thickness of metal films which polarise platinum	Oberbeck.
1—0·02	Thickness of electric double layer	Lippmann and Oberbeck.
0·2	Smallest appreciable thickness of silver film	Wiener.
0·14—0·11	Diameter of gaseous hydrogen molecule	Exner. O. Meyer. Van der Waals.
0·07—0·02	Mean distance between centres of nearest liquid molecules..	W. Thomson.
0·02	Inferior limit to diameter of gaseous molecule	W. Thomson.

Certain Ammoniacal Combinations of the Nickel Salts.—G. André.—Only a single nickel ammonium chloride, $NiCl,3NH_3$ is obtained by the moist way. One of the author's attempts to prepare a different compound yielded merely nickel oxychloride. Nickel ammonium sulphates are more easily obtained, the author having prepared two in addition to that formerly described by Erdmann and Laurent. There exists only a single nickel ammonium nitrate.—*Comptes Rendus*, Vol. cvi., No. 13.

A METHOD FOR THE SEPARATION AND DETERMINATION OF BORIC ACID.

By H. N. MORSE and W. M. BURTON.

The indicator, tropæolin OO, not being sensitive to boric, carbonic, and silicic acids, or to their salts, it is practicable to liberate exactly one or all of these acids in any mixture of inorganic substances. In other words, if to a solution containing silicates, carbonates, and borates, and any other inorganic salts or hydroxides, we add tropæolin and then dilute sulphuric acid, we shall not obtain an acid reaction until all of the silicic, carbonic, and boric acids have been liberated. In the meantime, any oxides or hydroxides which were present will have been converted into sulphates, so that the mixture will finally consist of neutral salts, water, silicic, carbonic, and boric acids. If we now add to this mixture a sufficient quantity of dehydrated copper sulphate, the water will be absorbed and the silicic acid dehydrated. The mass will then consist of neutral salts, silica, and boric acid, of which only the boric acid is soluble in absolute alcohol. These facts enable us to separate boric acid with great exactness from nearly all other forms of inorganic matter. The only classes of salts known to us at present which are at all likely to interfere with such a separation are the chlorides and the compounds of iron, but both of these may be readily removed before the acids in question are liberated. The boric acid thus separated may be determined as a meta-borate of calcium, magnesium, or barium. We prefer the last form; because a mixture of carbonate and meta-borate of barium, being neither markedly hygroscopic nor capable of absorbing carbon dioxide, can be brought to a constant weight more readily than one containing the oxide of calcium or magnesium. Moreover, the use of barium enables us to employ a standard solution of hydroxide to receive the alcoholic extract of boric acid, thus saving the labour of bringing the absorbing material itself to a constant weight.

The Reagents.

1. An aqueous solution of tropæolin OO.

2. A standard solution of sulphuric acid of such strength that 1 c.c. of it is equivalent to 20 m.grms, of barium carbonate.

3. A solution of barium hydroxide approximately equivalent to the sulphuric acid. This is prepared by agitating the solid commercial hydroxide with a little cold water, filtering, and washing with cold water. The residue, thus freed from the caustic alkalies, is transferred to a flask or bottle and treated with water. From this solution the more dilute ones are prepared as they are needed.

4. Dehydrated copper sulphate prepared from the pure salt by heating in an air-bath at 150° until the whole mass assumes a uniform light colour. It is necessary to use pure copper sulphate for this purpose. The presence either of chlorides or of iron salts is not permissible, because of the solubility of cupric chloride and ferric sulphate in alcohol. It is not advisable to attempt to remove more than four of the five molecules of water of crystallisation, because of the danger of decomposing some of the salt at high temperatures. Such decomposition would result in the formation of free sulphuric acid, which would be extracted along with the boric acid by alcohol.

5. Absolute alcohol prepared by digesting for two or three days with dehydrated copper sulphate an alcohol which has previously been distilled over lime. The complete drying of the alcohol is important.

The Mode of Procedure.

If the boric acid is in solution, the liquid containing it is made slightly alkaline with caustic potassa, and evaporated on a water-bath in a porcelain dish having a width of about 100 m.m. The volume of the solution should be reduced to 10 or 12 c.c. The separation of salts during evaporation will not interfere with subsequent operations. If the material containing the boric acid is not soluble in water, a silicate for example, a solution is effected by the method recommended by one of us for the decomposition of chrome iron.* About 4 grms. of the purest solid potassium hydroxide are placed in a nickel crucible† and heated with a small flame until the fused mass becomes perfectly tranquil. The crucible is allowed to cool, and the finely ground and weighed material spread over the surface of the solidified hydroxide. The whole is then heated for two hours to a temperature just sufficient to keep the hydroxide in a fused condition. During the decomposition the mass is frequently stirred with a stout platinum wire, which is allowed to remain in the crucible. This method of bringing the acid into a soluble condition is to be preferred to fusion with the alkaline carbonates, since it yields a mass from which everything soluble can be readily extracted by water. The crucible is placed on its side in a porcelain dish, treated with hot water, and the soluble separated from the insoluble matter by filtration and washing. The filtrate is then evaporated to the small volume previously mentioned. If the material thus decomposed contains iron, the contents of the crucible must be treated with not less than 400 c.c. of water, and the dish in which the solution is made should be heated on the water-bath for a considerable time, with replacement from time to time of the evaporated water. Otherwise the separation of the iron may not be complete.

The solution of borate is treated, under proper covering to prevent loss by spattering, with a drop or two of tropæolin solution, and then with the ordinary desk solution of sulphuric acid until a distinct and permanent acid reaction is obtained. The material on the under side of the cover is washed back into the dish with the least possible amount of water, and the slight excess of sulphuric acid carefully neutralised by means of very dilute caustic potassa. The solution of boric acid, which should not exceed 20 c.c. in volume, is now thoroughly dried by slowly stirring into it the anhydrous copper sulphate, care being taken not to permit any considerable rise in temperature. The mass is afterwards pulverised with a pestle.

The extraction apparatus consists of a narrow Erlenmeyer flask having a capacity of about 150 c.c., and a straight chloride of calcium tube somewhat larger than is necessary to contain the mixture which is to be extracted. The narrow portion of the tube is plugged with cotton-wool. To its lower end is attached, by means of rubber tubing, a small glass tube which reaches to the bottom of the flask when the stopper carrying the extraction tube is in position. The quantity of the dilute barium hydroxide solution which is equivalent to 25 c.c. of the standard sulphuric acid is run into the flask, and the apparatus attached to the filter-pump. This quantity of the hydroxide would weigh, if converted into carbonate, just 500 m.grms. During the filling of the extraction tube with the copper sulphate mixture, the outside is occasionally tapped to render the material more compact.

The porcelain dish is washed with several small portions of absolute alcohol, which are then poured into the tube. When the whole of the copper sulphate has become wet with the alcohol the pump is shut off, and the mass allowed to soak for fifteen minutes. Afterwards five other portions of absolute alcohol, of 15 c.c. each, are poured into and slowly drawn through the tube, care being taken to allow each portion to filter through completely before another is added.

Finally, the excess of the barium hydroxide is precipitated by passing into it a current of carbon dioxide; the contents of the flask are transferred to a weighed platinum dish, evaporated to dryness, and heated to constant weight over a triple burner.

* *American Chemical Journal*, iii., 163.

† A silver crucible is not to be recommended, because of the solubility of silver in potassium hydroxide.

The quantity of boric anhydride is found by the following proportion :—

Mol. weight of B_2O_3—mol. weight of CO_2 : mol. weight of B_2O_3 :: weight found—theoretical weight of the barium as carbonate : weight of B_2O_3 found.

If the atomic weights of Clarke have been used throughout, the difference between the weight found and the calculated weight of the carbonate (500 m.grms.) is to be multiplied by the number 2·697012; if those of Meyer and Seubert have been employed, this difference is to be multiplied by the number 2·701822.

The accuracy of the method was tested by determining the boric acid in pure borax glass (prepared by ourselves), in datholite from Bergen Hill, and in tourmaline from Pierrepont, N.Y.

We give the results below :—

I. *Borax Glass.*

Measured portions of a standard solution were employed.

Theoretical percentage of B_2O_3, 34·61. Found, 34·64, 34·58, 34·64, 34·57, 34·57.

Five determinations made by Mr. R. L. Henderson of this Laboratory (Chemical Laboratory, Johns Hopkins University) gave the following percentages of B_2O_3 in our borax glass :—34·60, 34·60, 34·59, 34·58, 34·59.

II. *Datholite from Bergen Hill.*

Theoretical percentage of B_2O_3, 21·82. Found, 21·75, 21·68, 21·62, 21·65, 21·64. Mean, 21·67.

III. *Tourmaline from Pierrepont.*

This mineral was recently carefully analysed by Dr. Riggs.*

Five determinations of the boric acid were made by ourselves, one by Mr. C. C. Blackshear, and one by Mr. Henderson.

Percentage of B_2O_3 found by Dr. Riggs, 10·15, 10·00, 10·31; by ourselves, 10·03, 10·08, 10·11, 10·03, 10·13, Mean, 10.08. Found by Mr. Blackshear, 10·02; by Mr. Henderson, 10·12.—*American Chemical Journal*, Vol. x., No. 2.

* *American Journal of Science*, xxxv., 45.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

April 14th, 1888.

Shelford Bidwell, F.R.S., Vice-President, in the Chair.

Mr. W. E. Sumpner, B.Sc., read a paper on "*The Variation of the Coefficients of Induction.*"

The author pointed out that there are three ways of defining the coefficient of self-induction of a circuit, expressed by the following equations :—

$$(1)\ e = L_1 \frac{dc}{dt}. \qquad (2)\ N = L_2 C.$$

$$(3)\ T = \tfrac{1}{2} L_3 C^2.$$

Where e = back E.M.F. due to change of current, C = current, N = total induction through the circuit, and T the kinetic energy of the circuit.

If the medium be air, L_1, L_2, and L_3 are identical, but in the case of iron this is no longer so.

When the curve of magnetisation is given, their values corresponding with any value of C can be easily determined by the above equations.

Maxwell's absolute method of measuring self-induction gives L_2; and by a modification due to Prof. Ayrton, where the current is altered from C_1 to C_2 instead of from o to $C = \frac{C_1 + C_2}{2}$, the value of L obtained is approximately L_1, if $C_1 - C_2$ is small compared with C.

From the known character of the curves of magnetisation of iron, it is easily seen that the value of L_2 increases with the current when the current is small, then becomes nearly constant, and afterwards decreases. For an electro-magnet having a horseshoe core of best Swedish iron, ½" diameter and 14" long, wound with 800 convolutions, the value of L_2 for currents between 0·047 and 0·107 amp. was found to satisfy the equation—

$$L_2 = \frac{A}{5} + 0{\cdot}0425,$$

where A = current in ampères.

A method of comparing self-induction with capacity is described in which the arms of a Wheatstone bridge, opposite the one containing self-induction, is shunted by a condenser of capacity, K. The bridge is balanced for steady currents, and the deflection, θ_1, of the galvanometer observed on breaking the battery circuit.

θ_1 is :: $L_2 - Kps$, where p and s are the resistances of the two remaining arms of the bridge. The condenser is then disconnected, and another swing, θ_2, obtained on again breaking the battery circuit.

$$\theta_2 \text{ is :: } L_2 \therefore \frac{\theta_2}{\theta_1} = \frac{L_2}{L_2 - Kps},$$

Or—

$$L_2 = \frac{\theta_2}{\theta_2 - \theta_1} . Kps.$$

Further experiments were made on the electro-magnet when its poles were joined by a piece of soft iron, the currents being reversed. The resulting values of L_2, $\mathfrak{B}$, $\mathfrak{H}$, and μ are given in absolute measure, and from them the author deduces—

$$L_2 = 0{\cdot}05 + 3{\cdot}9\,A, \quad \mu = 210 + 720\,\mathfrak{H}, \quad \mathfrak{B} = 210\,\mathfrak{H} + 720\,\mathfrak{H}^2,$$

for values of A between 0·06 and 0·9. The difficulties experienced in determining the induction coefficient for strong magnetising forces produced by the testing current are described. They arise chiefly from the fact that in order to obtain strong currents the resistances must be small. This makes the "*time constant*" large, and in order to obtain the values of L in absolute measure a ballistic galvanometer of very long period would be required. A method of calibrating a galvanometer of comparatively short period, to give approximate results, is described.

Where the magnetising force is produced by an independent coil no such difficulties present themselves. Results obtained for the coefficients of self-induction of a gramme armature (A type), for different currents round the field's magnets, vary from 0·0218 for current o to 0·0117 for a current of 29 ampères.

The value of L for a given point on the curve of magnetisation is not a definite quantity, but has always two or more distinct values, depending on whether the magnetisation is increased or decreased by the test current and on the previous history of the iron. That this must be the case is easily seen from the curves obtained by Prof. Ewing in his "Experimental Researches on Magnetism." The values of L, corresponding to the three sides of a small Ewing cycle, are denoted by L_p ("*progressive coefficient*"), L_r ("*return coefficient*"), and L_c ("*cyclic coefficient*"). L_p is always the largest, whether the magnetisation be increased or decreased by the testing current. Numerical values of L_p and L_c obtained from a Kapp and Snell transformer are given. L_c can be very accurately determined by Profs. Ayrton and Perry's secohmmeter, and some of the results given in the paper were thus obtained.

Having given the curve of magnetisation,, and that connecting impressed E.M.F. and time, a simple graphical method is described for drawing the current curve.

Applying this to an alternating current where the E.M.F. is a pure sine junction of the time, it is shown that the resulting current curve differs considerably from a sine curve. The case of the rise of current in the magnet coils of a dynamo excited by accumulators is also discussed, the desired curves being in accordance with observation.

In conclusion, the author pointed out that the time taken to discharge a condenser through a given resistance may be decreased by adding self-induction to the circuit, provided L is less than $\frac{1}{2} KR^2$. When $L = \frac{1}{4} KR^2$ the discharge is completed in one-half the time required when $L = 0$. This may account for the remarkable results observed by Dr. Lodge in his experiments on iron and copper as lightning conductors.

Mr. C. V. Boys described and performed "*Some Experiments on Soap-Bubbles*," and by their aid demonstrated in a remarkable manner the phenomena of surface tension, diffusion, and the magnetic properties of gases. By blowing one bubble inside another he showed that there is no electrical force inside a closed conductor. A peculiar property of soap-bubbles is their refusal to come into contact when knocked against each other; they may receive violent shocks, and still remain separate. If, however, an electrified body be brought in the vicinity, they immediately coalesce. So sensitive are they to electrical attraction that a potential difference due to one Léclanche cell between the two bubbles causes them to unite. They may thus serve as very delicate electroscopes.

Many other beautiful and extremely interesting experiments, on liquid films of different shapes, were performed in a masterly manner.

CORRESPONDENCE.

THE USE OF THE TERMS "ANALYSIS" AND "ASSAY."

To the Editor of the Chemical News.

Sir,—Permit us to reply to Mr. Allen's letter in the Chemical News (vol. lvii., p. 140). He favours us with three definitions of "Analysis," of which we can only admit the first, whilst even this is incomplete, and also betrays his lurking sense of the inaccuracy of the second and third, in that he terms the first "*a.* A true analysis, or separation of a substance into its constituent parts," which "true analysis" he justly witholds from his later definitions. Mr. Allen does not attempt a definition of the term "Assay," occupying three paragraphs of your Journal in describing his own meaning of it.

With your permission we would rest our contention of the strict and definite meanings of analysis and assay, not on our own notions, but on the definitions of a master in the art, the late Richard Phillips, F.R.S., of the Royal School of Mines, and formerly a President of the Chemical Society, to be found in "The Penny Cyclopedia of the Society for the Diffusion of Useful Knowledge," 1833.

"Chemical analysis is the separation of compound bodies either into their simpler or their elementary constituents," and

"'Assay,' or rather 'assaying,' a chemical operation which differs from analysis only in degree. Where an analysis is performed the nature and properties of all the ingredients of a substance are determined; but in assaying the quantity of any particular metal only which the ore or mixture under examination may contain is ascertained, without reference to the substances with which it is mixed or alloyed."

We would venture to add to the above that in this article "Assaying" is confined to metals and their ores, and the processes to "furnacing," as we have somewhat rudely termed it. It does not contain even the most remote hint that the term "assaying" can be further extended, which compels us to the explicit denial of Mr. Allen's question, "Cannot we have an 'assay' of sulphur ore, bleaching-powder, or alkali, unless the operation is conducted in a furnace." In confirmation of the foregoing we may say that Berthier, in his exhaustive "Traité des Essais par la Voie sèche," never contemplates the extension of "essai" beyond its application to metals and their ores.

In his protest against our statement that he used the phrase "Assay of Morphia," Mr. Allen is fully justified, and we would beg of him to accept our apology for having made it. How this error arose does not matter; we ought to have detected and corrected it in the proof, but not having done so the blunder is fairly fastened on us. Probably we meant Assay of Opium. Be this as it may, we at once accept Mr. Allen's assurance that he "cannot find in his writings the expression 'Assay of Morphia.'" May we add that we hope he will yet avoid the use of "assay" in connection either with opium or with morphia.—We are, &c.,

E. F. Teschemacher and J. Denham Smith.

Highbury, April 11, 1888.

TITRATION OF MORPHIA.

To the Editor of the Chemical News.

Sir,—I should feel much obliged to Messrs. Teschemacher and Smith if they will kindly describe somewhat more in detail the method of titrating the crude morphia obtained by their method. I have found considerable difficulty in obtaining anything approaching to a sharp end reaction with litmus. And this difficuly must be considerable when "colouring and other organic matters" are present to the extent of ten per cent.—I am, &c.,

Carter Napier Draper.

Dublin, April 12, 1888.

HOW IS IT DONE?

To the Editor of the Chemical News.

Sir.—The following is the reply which I received in response to a request for more precise information regarding some analytical work offered to me.

"We would require about 36 samples weekly to be analysed for total solids, and butter-fat, &c., merely. They would arrive on certain fixed days which could be arranged to suit your convenience. What we paid here was £20 for the whole season, ranging from April till November. As the season advances the number of samples would gradually lessen. The sum mentioned would be for the whole season. We shall be happy to hear from you at your earliest convenience if you can undertake this duty. If the remuneration would not be satisfactory, you could state an average price per sample with a minimum limit."

If my calculations are correct the remuneration here specified is less than 4d. per sample? Can any of the readers of the Chemical News tell me how to make milk analyses pay at this rate?

Mr. Walter Besant talks eloquently of the "Law of 11½d."; does he know anything of the Law of 3¾d.?—I am, &c.,

Thomas Farrington, M.A., F.C.S., F.I.C.,
Analyst to the County Cork Agricultural Society.

Analytical Laboratory, 4, Waterloo Place,
Cork, April 17th, 1888.

Action of Bromine upon the Compounds of Aldehyds and Glycol.—H. Lochert.—The result of the reaction of bromine with ethylic aldehyd is a solid mass consisting of crystalline laminæ. Very little bromine escapes.—*Bull. de la Soc. Chim. de Paris*, Vol. xvi., No. 11.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 13, March 26, 1888.

The Relations of Atmospheric Nitrogen with Vegetable Mould.—Th. Schlœsing.—The disappearance of oxygen shows that the combustion of organic matters has taken place in the samples of soil in different degrees, depending on the quantities and the nature of these matters. During this combustion nitric acid has been formed and ammonia has disappeared. The volumes of gaseous nitrogen contained in the atmospheres of the samples have not varied sensibly; the very trifling variations observed, in excess or in deficiency, do not exceed the limits of errors committed in measuring and analysing gases.

The Absorption of Saline Matters by Vegetables: Potassium Acetate and Nitrate.—MM. Berthelot and André.—The presence of a considerable proportion of potassa in the soil in a form easy of absorption does not exert a marked influence on the fixation of this alkali by plants. Potassium nitrate exists in the tissues of most plants in such a proportion that it must be formed in the tissues.

The Formation of the Hydrates of Gases.—MM. de Forcrand and Villard.—At the moment when a gas forms a crystalline hydrate with water it is not simply a saturated solution which solidifies, but a considerable excess of the gas disappears and combines with the water of the solution to form a solid compound.

The Use of Thompson's Calorimeter to Determine the Practical Heating-power of Coal.—M. Scheurer-Kestner.—It results from the author's experiments that if the Thompson calorimeter can supply practical men with sufficient indications when only an approximate result is required, it is not worthy of unlimited confidence.

The Fixation of Nitrogen by the Soil and by Plants.—Arm. Gautier and R. Drouin.—A former series of experiments had shown that the soil, if it contains organic matter, can fix nitrogen independently of vegetation. The second series shows that vegetation constitutes an additional method of fixing nitrogen.

Certain Derivatives of Ortho-aldehydo-phthalic Acid.—S. Raeine.—This paper is not adapted for useful abstraction.

Bulletin de la Société Chimique de Paris. Vol. xlviii., No. 11, December 5, 1887.

Researches on the Emission of Ammonia by Vegetable Mould.—MM. Berthelot and André.

Researches on Drainage.—M. Berthelot.

The Direct Fixation of the Gaseous Nitrogen of the Atmosphere by Vegetable Soils.—M. Berthelot.

Direct Fixation of the Gaseous Nitrogen of the Atmosphere by Vegetable Soils in Presence of Plants.—M. Berthelot.

The Various States of Tellurium.—MM. Berthelot and Fabre.

Formation-heat of Hydro-telluric Acid.—MM. Berthelot and Fabre.

Graduation of Tubes for Gasometric Measurements.—M. Berthelot.

The Calorimetric Bomb and the Measurement of Combustion-heats.—MM. Berthelot and Recoura.

Combustion-heats.—MM. Berthelot and Louguinine.

The Transit from the Aromatic to the Fatty Series.—MM. Berthelot and Recoura.—All the above memoirs have appeared in substance elsewhere and have been already noticed.

The Caprylidene of Caprylene; its Isomerism with the Caprylidene of Caprylic Aldehyd.—A. Béhal.—The caprylidene of caprylene is a substituted acetylenic carbide, since it does not react with cuprous chloride or ammoniacal silver nitrate. This carbide is methyl-amyl-acetylene, an isomer of the caprylidine of caprylic aldehyd.

Some Chloro-derivatives of Acetic Ether.—M. Maurice Delacre.—Of the 48 theoretically possible derivatives formed by chlorine in successively displacing the eight atoms of hydrogen in acetic ether, the authors have prepared and examined mono-chloro-ethyl-acetate, mono-chloro-ethyl-mono-chloracetate, mono-chloro-ethyl-bichloracetate, mono-chloro-ethyl-trichloracetate, bichloro-ethyl-acetate, bichloro-ethyl-mono-chloracetate; bichloro-ethyl-bichloracetate, bichloro-ethyl-trichloracetate, trichloro-ethyl-acetate, trichloro-ethyl-mono-chloracetate, trichloro-ethyl-dichloracetate, and trichloro-ethyl-trichloracetate.

Compounds of Aldehyds and Glycol.—H. Lochert.—The author describes the isobutylic and propionic aldehyds.

Certain Derivatives of Saccharic and Mucic Acid.—M. Maquenne.—It is known that the neutral ethers of saccharic and mucic acid yields with acetyl chloride isomeric tetracetylic derivatives. The author has endeavoured to prepare the corresponding acids by means of zinc chloride, and finds that under these conditions saccharic and mucic acid do not yield the same derivatives.

No. 12, December 20, 1887.

New Method of Forming Safranines.—MM. Ph. Barbier and Leo Vignon.—The authors have shown that phenosafranine and its homologues may be prepared by the reaction of the paramido-azo-derivatives, such as amido-azo-benzol and amido-azo-toluol upon the mono-nitro mono-benzenic carbides in presence of reducing agents.

MEETINGS FOR THE WEEK.

MONDAY, 23rd.—Medical, 8.30.
— Society of Arts, 8. "Milk Supply, and Butter and Cheese Making," by Richard Bannister, F.I.C., F.C.S.
— Society of Chemical Industry, 8. "Notes on the Manufacture of Chlorine," by Mr. Kingzett. "Further Notes on Electrolytic Bleaching—Hermite's process," by Messrs. Cross and Bevan.

TUESDAY, 24th.—Institution of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Royal Institution, 3. "John Ruskin," by Charles Waldstein, Ph.D.
— Society of Arts, 8. "Craftsman and Manufacturer,' by Lewis Foreman Day.

WEDNESDAY, 25th.—Geological, 8.
— Society of Arts, 8. "The Physical Culture of Women," by Miss Chreiman.

THURSDAY, 26th.—Royal, 4.30.
— Telegraph Engineers, 8.
— Royal Institution, 3. "The Chemical Arts," by Professor Dewar, M.A., F.R.S.

FRIDAY, 27th.—Quekett Club, 8.
— Royal Institution, 9. "Electrical Influence Machines," by James Wimshurst.

SATURDAY, 28th.—Royal Institution, 3. "The Later Works of Richard Wagner," by Carl Armbruster.
— Physical, 3. "On Electromotive Force by Contact," by C. V. Burton. "On a Theory Concerning the Sudden Loss of Magnetic Properties of Iron and Nickel," by H. Tomlinson. "Note on the Graphic Treatment of the Lamont Frölich Formula for Induced Magnetism," "Note on the Conditions of Self-excitement in a Dynamo Machine," and "Note on the Conditions of Self-regulation in a Constant Potential Dynamo Machine," by Prof. S. P. Thompson.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Boracic Acid.—Can any one favour with a description of an accurate quantitative method for determination of boracic acid in minute proportions; in meat, for instance?—W. K. Y.

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By Order,
WILLIAM E. VINSON,
Secretary.

Gas Offices, Gloucester,
April 13th, 1888.

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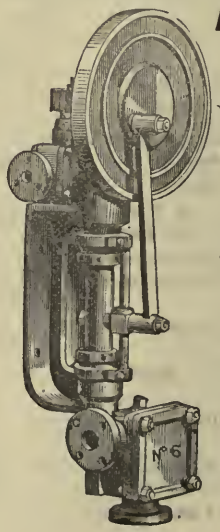

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THE CHEMICAL NEWS.

Vol. LVII. No. 1483.

ON THE LOGARITHMIC LAW OF ATOMIC WEIGHTS.*

By G. JOHNSTONE STONEY, M.A., D.Sc., F.R.S.

This memoir is divided into five sections.

Section 1.—When Newlands pointed out the dependence of the atomicity and other properties of some of the chemical elements upon the order in which their atomic weights succeed one another, and especially when this law was extended by Mendeleeff to all the elements, it became manifest that there exists a mathematical relation between a series of numbers and the successive atomic weights of the elements.

In the first section the reason is pointed out why the search for this law has been fruitless, at least as hitherto pursued by the author. The method he adopted was to plot down the atomic weights as ordinates of a diagram of which the abscissæ represented some simple numerical series, and to endeavour to extract information from the resulting curves. In this method atomic weights are represented by lines, the ordinates of the figure. Now in the next section it will appear that, in that case, the curve is represented by the equation—

$$y = k\ (\log x)^{\frac{1}{2}},$$

and is further complicated by x not representing simple integer numbers, but a circular function of them. The search, therefore, by this method was from the first hopeless, as the resulting curve is one which has not been studied by geometers, and of which accordingly the inquirer could not recognise the appearance when presented to him.

In Section 2 another method is pursued. The successive atomic weights, instead of being represented by lines, are represented by volumes. A succession of spheres are taken whose volumes are proportional to the atomic weights, and which may be called *the atomic spheres*. When the radii of these spheres are plotted down on a diagram as ordinates and a series of integers as abscissæ, the general form of the logarithmic curve—

$$y = k \log (qx)$$

becomes apparent: and close scrutiny has shown that it expresses the real law of nature. It is the central curve that threads its way through the positions given by observation, and the deviations from it of the positions assigned by the actual atomic weights will be included by making x a circular function of integer numbers, instead of those numbers themselves. The first three terms of this function have been determined.

The issue of the investigation is to show that when such a diagram is formed with ordinates which are the cube roots of the atomic weights referred to hydrogen as unit, so that the ordinates may be the radii of spheres whose volumes represent the atomic weights—

1. The logarithmic curve—

$$y_m = k\ .\ \log (m\alpha),$$

(where $\log k = 0{\cdot}785$

and $\log \alpha = \bar{1}{\cdot}986$)

threads its way through the positions plotted down from the observations.

2. In the case of the perissads (the elements of uneven atomicity) the complete curve which includes their perturbations from the central curve is—

$$y_m = k \log \left[\alpha \left(m + \tfrac{1}{3} \sin \frac{m\pi}{27} + \tfrac{1}{3} \sin \frac{m\pi}{18} + \text{subsequent terms} \right) \right]$$

the next being probably either—

$$-\tfrac{1}{2} \sin \frac{m\pi}{9}, \qquad \text{or} \qquad -\tfrac{2}{3} \sin \frac{m\pi}{9}$$

3. The form of the function representing the perturbations of the artiads is different, at all events after the third term.

Section 3.—There are other neighbouring logarithmic curves which pursue a course close to the observed positions, and in Section 3 the method adopted in dealing with these curves is described, and the grounds on which they have been successively excluded are stated. The evidence relied on has been, for the most part, that the perturbations from them are less reducible to order.

In Section 4 the curve finally selected is thrown into a polar form, and furnishes a diagram of singular convenience for laboratory use. It presents conspicuously the informa- which a Newlands and Mendeleeff's table is capable of supplying, with the further advantage of also placing before the eye an intelligible representation of the atomic weights.

The last section contains some observations suggested by the investigation.

* Abstract of a Paper read before the Royal Society, April 19th, 1888.

ON THE COMPOUNDS OF AMMONIA WITH SELENIUM DIOXIDE.*

By Sir CHARLES A. CAMERON, V.P.I.C., F.R.C.S.I., and JOHN MACALLAN, F.I.C.

The following experiments were undertaken with the object of determining the action of ammonia upon selenium dioxide. They have resulted in the discovery of two new compounds, which, from what has been ascertained regarding their constitution, may perhaps be best designated by the term *selenosamates:* they are ammonium compounds of an acid (yet to be isolated) which we name *selenomosic.*

Preparation of Neutral Ammonium Selenosamate.

Ammonia, which had been carefully dried by passing through a series of potash tubes, was led into a solution of selenium dioxide in absolute alcohol. After being absorbed for some time, minute crystals commenced to deposit, and when complete precipitation had taken place the liquid portion was filtered off, the crystals washed with alcohol, and dried over sulphuric acid in a vacuum.

The compound thus formed was found to be a deliquescent salt, which separates from its solution in alcoholic ammonia in minute, but very well-defined, hexagonal prisms and pyramids, both forms often occurring in combination. It is a very unstable substance, continuously liberating ammonia, and tending to the formation of a more stable acid salt. Some of the crystals which had been placed in a large stoppered bottle were found after some weeks to be entirely converted into large crystals of the acid salt. It also loses ammonia when treated with alcohol or water; and when its aqueous solution is evaporated in a vacuum, crystals of the acid salt remain. When heated, it is at once converted into the acid salt. On account of its instability it is best prepared in a partial vacuum, and when dried placed in a stoppered bottle, which should be quite full and kept in a cool place. In this way it may be preserved of definite composition for a considerable time. It is with difficulty, and but partially,

* A Paper read before the Royal Society, April 19th, 1888.

converted into ammonium selenite by the action of water upon it. When barium chloride is added to its neutral aqueous solution, only a faint cloudiness is produced, until it is heated, when a slight precipitate forms, but, even after standing for weeks and long-continued boiling, only a portion of the selenium precipitates. Addition of excess of ammonia to the solution, however, precipitates a basic barium salt. It is but sparingly soluble in cold alcoholic ammonia. 1·6658 grms. of solution, from which crystals had deposited left a residue of 0·0134 grm., reduced to acid salt, which is equivalent to a solubility of one part in 116 at 12°. Heated with the alcoholic ammonia it dissolves freely, but on cooling the solution remains long supersaturated, crystals continuing to deposit for several days. It is very slightly volatile at ordinary temperatures, both in a vacuum and in a current of air. As might be expected, potash at once liberates ammonia from it. Sulphurous acid and stannous chloride reduce it with separation of selenium. It is only slightly affected by hydrochloric or nitric acid in the cold, but strong sulphuric acid reacts violently upon it, a portion of the salt being sublimed by the heat evolved. Chlorine passed through its aqueous solution converts it completely into ammonium selenate, a reaction which was taken advantage of for its analysis. 0·7820 grm. was dissolved in water, saturated with chlorine, and barium chloride added. The resulting barium selenate weighed 1·5150 grms., equivalent to a percentage of 76·84 of selenium dioxide. The ammonia was estimated by Kjeldahl's process, slightly modified on account of the volatility of the substance. 0·5651 grm. was mixed roughly with potassium permanganate in a small strong flask by means of a glass rod, after which a thin tube containing 10 c.c. of sulphuric acid mixture was lowered into it, and broken by shaking the flask after it had been well secured with an india-rubber cork. It was then heated to 150° for one hour in a paraffin bath. The contents of the flask distilled with potash yielded 0·13175 grm. of ammonia, equivalent to a percentage of 23·32. The results obtained agree with the composition $2NH_3,SeO_2 = NH_4,SeO_2NH_2$.

	Calculated.	Found.
SeO_2	76·53	76·84
NH_3	23·47	23·32
	100·00	100·16

The original alcoholic solution from which the crystals had deposited was found to contain selenium. In order to ascertain in what form it existed a portion of the solution was evaporated to dryness in a vacuum. The residue weighing 0·666 grm., treated as before, yielded 1·285 grms. of barium selenate, equivalent to 76·53 per cent of selenium dioxide, the theoretical amount in the above compound showing that a portion remained in solution after the crystals had deposited. It was considered a matter of interest to ascertain how much of the nitrogen in this salt would be precipitated by platinum chloride. 0·5772 grm. was accordingly taken, platinum chloride poured upon it, alcohol added, and the mixture allowed to stand in the cold. The double chloride obtained weighed 1·5502 grm., equivalent to a percentage of 20·59 of ammonia. A second estimation, in which 0·4153 grm. was taken, yielded 1·1206 grms. of the double chloride, equivalent to 20·69 per cent of ammonia. In a third estimation 0·3835 grm. was evaporated down with platinum chloride, but the double chloride obtained, 1·0237 grm., showed a rather smaller percentage of ammonia, namely, 20·52. The mean of the first two results, 20·64, is equal to 87·94 per cent of the total ammonia, and indicates that, in addition to the basic nitrogen, about three-fourths of the nitrogen contained in the radical of the salt is precipitated by platinum chloride.

Preparation of Acid Ammonium Selenosamate.

A solution of the neutral salt in absolute alcohol was boiled down on the water-bath until crystals were deposited. The liquid portion was then drained off, and the crystals washed with alcohol, and dried in a vacuum. On examination they proved to consist of an acid salt. It was also found that exposure of the neutral salt in a vacuum over sulphuric acid for thirty hours was sufficient to convert it into the same acid compound. A portion of the salt obtained in the latter way was submitted to analysis. For estimation of the selenium 0·2 grm. was dissolved in water, saturated with chlorine, and precipitated with barium chloride. The resulting barium selenate weighed 0·409 grm., equivalent to a percentage of 81·11 of selenium dioxide. In a second estimation 0·4268 grm. yielded 0·8761 grm. of barium selenate, equivalent to 81·42 per cent of selenium dioxide. Kjeldahl's process was found to be unsuitable in this case for estimating the ammonia, the amount yielded by it being much too low, although a very high temperature was maintained for a considerable time. Combustion with soda-lime also gave insufficient results, owing to a portion of the substance being decomposed by the heat employed, with evolution of nitrogen. Somewhat better results were obtained by Dumas's process: 0·4035 grm. yielded 49·9 c.c. of nitrogen at 12° and 771·6 m.m., equivalent to a percentage of 18·09 of ammonia. An estimation of the selenium in the dried crystals was also made: 0·1523 grm. yielded 0·3134 grm. of barium selenate, equivalent to 81·62 per cent of selenium dioxide. The results thus obtained agree with the formula—

$$2SeO_2,3NH_3 = NH_4,H,(SeO_2NH_2)_2.$$

	Prepared in vacuum.		Crystallised from alcohol.	Calculated.
	1.	2.	3.	4.
SeO_2 ..	81·42	81·11	81·62	81·30
NH_3 ..	18·09	—	—	18·70

The salt thus obtained is deliquescent, and easily soluble in alcohol, from which it separates in large prisms. 2·0270 grms of saturated solution left a residue weighing 0·1191 grm., showing a solubility of one part in sixteen of absolute alcohol at 14°. No hydrate was obtained by evaporating its aqueous solution, but the same crystalline forms were deposited as from alcohol. With barium chloride it behaves similarly to the neutral salt, a partial precipitation taking place only with difficulty. It possesses much greater stability than the neutral salt, but like the latter it is reduced by sulphurous acid and stannous chloride, and oxidised by chlorine. Potash decomposes it with evolution of ammonia, but hydrochloric, nitric, or sulphuric acid has only a slight action upon it in the cold. Kept in a vacuum or in a current of air, it is appreciably volatile at ordinary temperatures. When heated strongly a portion of it sublimes unchanged, part of it is converted into ammonium selenite, while the remainder is decomposed into ammonia, water, nitrogen, and a residue of fused selenium. In order to estimate the amount of ammonia precipitated by platinum chloride, 0·3140 grm. was taken, which yielded 0·6234 grm. of the double chloride, equivalent to 15·26 per cent of ammonia, the amount thus precipitated being equal to 81·60 per cent of the total amount of ammonia in the salt.

Relation of the Selenosamates to Sulphur Compounds.

It is stated that a compound is formed by the action of ammonia on sulphur dioxide, but the description of its properties shows that it does not correspond with the selenosamates. The latter bodies correspond more closely with the compounds which sulphur trioxide forms with ammonia. The molecule SeO_2, therefore, in these reactions acts similarly to SO_3, rather than to what is usually regarded as its sulphur analogue, namely, SO_2.

In conclusion, we are engaged at present in the production of other selenosamates, and hope to give an account of them at an early date.

Public Analyst for Islington.—The Vestry of St. Mary, Islington, on Friday, April 20th, elected Frank L. Teed, D.Sc., F.C.S., F.I.C., Public Analyst for the Parish.

ON THE

DETECTION AND ESTIMATION OF MAGENTA IN ORCHIL AND CUDBEAR.

By CHRISTOPHER RAWSON, F.I.C., F.C.S.

Various methods have been proposed from time to time for detecting the presence of magenta in orchil and cudbear. But on account of the difficulty hitherto experienced in completely separating orsein from salts of rosaniline, there are few, if any, published methods which are sufficiently delicate to detect very minute quantities of magenta in these colouring-matters. H. Crossley* precipitates the magenta by ammonia, and E. Knecht† makes use of caustic soda for the same purpose, but since rosaniline is appreciably soluble in alkalies, a small quantity of magenta would be entirely overlooked by the employment of either of these methods. Liebmann and Studer‡ saturate a solution of the orchil or cudbear with sulphurous anhydride, and, after filtering, add either acetone or aldehyd, when, if magenta be present, the colour of the liquid changes from red to violet. They state that by this reaction $\frac{1}{20}$ per cent of magenta in cudbear can be detected. In making use of this process, on account of the cudbear which remained in solution after saturating the liquid with sulphurous anhydride, I have been unable to detect such a small quantity.

The method which I have to propose is based upon the complete precipitation of the colouring-matter of orchil and cudbear in an aqueous and alcoholic solution by basic acetate of lead, followed by an excess of ammonia. Magenta, under the same conditions, remains in solution.

From 1 to 2 grms. of cudbear (or an equivalent amount of orchil liquor) are boiled with 50 c.c. of alcohol, and afterwards diluted with 100 c.c. of water; 15 to 20 c.c. of a strong solution of basic acetate of lead (sp. gr. 1·25) are then added, followed, after stirring, by a similar quantity of strong ammonia. The mixture is filtered, and if the amount of magenta present is to be *estimated*, the precipitate is washed with a solution containing 1 part of ammonia, 5 parts of alcohol, and 10 parts of water; otherwise the washing may be neglected. With pure cudbear the filtrate is quite colourless; if magenta be present it is either colourless or pink, according to the amount of ammonia present in the solution. The liquid is then acidulated with acetic acid, when the presence or absence of magenta is at once made apparent; in the case of pure cudbear or orchil the solution remains colourless, whereas, if a salt of rosaniline be present the well-known colour of magenta is immediately developed. If further proof be wanting, a small piece of worsted yarn may be dyed in the solution and afterwards tested in the usual way with such reagents as hydrochloric acid, caustic soda, and a mixture of hydrochloric acid and stannous chloride.

By means of this method I have been able to detect with certainty 1 part of magenta in 100,000 parts of cudbear.

For determining the *amount* of magenta present I make use of a colorimetric process. A standard solution of pure magenta is prepared so as to contain 1-100th milligrm. per c.c. It is acidulated with acetic acid in order that it may be under the same conditions as the solution to be tested. The latter is made up to a known bulk, say 250 c.c. (or, if magenta present be very small, concentrated to 100 c.c. and the whole taken for estimation), and an aliquot part run into a Nessler tube and diluted to 100 c.c. The standard solution of magenta is then run from a burette into a second cylinder in such quantity that the depth of colour is equal to that in the first, as in the case of Nesslerising ammonia. The amount of magenta present in the sample of cudbear or orchil under examination can be then readily calculated. In place of Nessler tubes the colorimeter or Lovibond's tintometer might be used with advantage.

It will no doubt be apparent from what I have already stated that this method is capable of detecting very much smaller quantities of magenta than the manufacturer of cudbear would ever think of using for the purpose of adulteration. But as the amount present can, at the same time, be easily and readily estimated, there is little danger of a sample of genuine cudbear which may have become accidentally contaminated with a trace of magenta, being pronounced sophisticated.

In a valuable paper on the "Detection of Adulterations in orchil and cudbear" F. Breiul* employs basic acetate of lead for detecting magenta and other basic coal-tar colours. Some time previous to the publication of that paper, however, I tried the same reagent at the suggestion of my friend Dr. E. Knecht, but a considerable amount of cudbear still remained in solution, and it was only by adding an excess of ammonia or soda that it was completely precipitated.

3, Union Street, Bradford.

* *Journal of the Societ of Dyers and Colourists*, vol. ii., p. 23.
† *Ibid.*, vol. ii., p. 58.
‡ *Journal of the Society of Chemical Industry*, vol. v., p. 287.

VOLUMETRIC ESTIMATION OF SULPHURIC AND PHOSPHORIC ACIDS.

By JOHN TSAWOO WHITE.

The delicate reaction of silver and chlorine with potassium chromate as indicator may be used for the estimation of sulphuric and phosphoric acids. The silver solution, 1 c.c. = 0·001 grm. Cl, as used for water analysis, will answer.

Fixed alkaline sulphates precipitated by barium chloride in excess will give an equivalent of alkaline chlorides. The excess of barium chloride precipitated by ammonium carbonate, the solution diluted to a definite volume, and a fractional volume filtered, evaporated, and ignited gently, will give the pure chloride. The alkaline chloride is dissolved and titrated, and the chlorine obtained is calculated for the total volume. Two trial experiments were undertaken. Two solutions containing 0·0349 grm. SO_3 and 0·0769 grm. SO_3 were slightly acidified with hydrochloric acid, the $BaSO_4$ and $BaCO_3$ precipitated, diluted to 250 c.c., and 50 c.c. evaporated, ignited, and titrated. The chlorine obtained was multiplied by 1·128, the factor for sulphur trioxide. The values obtained were 0·0375 grm. and 0·0741 grm. SO_3 respectively. Phosphoric acid interferes with the estimation. The sulphuric acid might, however, be determined. Separate the phosphoric acid by magnesia mixture, prepared with magnesium chloride; dilute with ammoniacal water to a certain volume, filter a known volume, evaporate to dryness, and ignite. The solution of the dissolved chlorides and sulphates is divided into two portions; one part is titrated for chlorine and the other part treated as for the estimation of sulphuric acid. The difference of the two titrations will give the chlorine equivalent of sulphuric acid. As I have not yet tried this separation I cannot state how far the magnesium chloride will interfere with the process.

Alkaline phosphates, in the tribasic form, are precipitated by silver nitrate, silver phosphate, Ag_3PO_4, being formed. Precipitating with excess of silver solution and neutralising any acid formed by calcium carbonate, the solution is diluted to 250 c.c. and 50 c.c. is filtered and titrated for the excess of silver by a solution of ammonium chloride, $As6Cl = P_2O_5$, chlorine 0·667 = phosphorus pentoxide. One trial in a solution containing 0·0152 grm. P_2O_5 gave 0·0141 grm. P_2O_5. Chlorides may be separated by evaporating with a slight excess of H_2SO_4, and then neutralising with soda before precipitating with silver nitrate.

* *Mitth. d. Techn. Gewerbemuseums in Wien*, 1887, 37.

Arsenic acid might also be determined like phosphoric acid.

Rangoon, March 29, 1888.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING MARCH 31ST, 1888.

By WILLIAM CROOKES, F.R.S.;
WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To GENERAL A. DE COURCY SCOTT, R.A., *Water Examiner, Metropolis Water Act*, 1871.

London, April 7th, 1888.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from March 1st to March 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

With the exception of two samples, the whole of the 182 samples examined were clear, bright, and well filtered.

The condition of the water furnished to the Metropolis during the past month by the two Companies taking their supply wholly or chiefly from the Lea, has not differed appreciably from that observable during the previous months of the year. In the case of the Thames-derived supplies, however, the occurrence of a more or less flooded state of the river throughout the greater portion of the month was not without some influence, although indeed to no significant extent, on the character of the water. Thus, while the mean proportion of organic carbon in the Thames-derived supplies examined during January and February was 0·155 part in 100,000 parts of water, the mean proportion in the samples examined during the past month was 0·162 part. But even this proportion is not at all excessive, either absolutely or for the season of the year; while the mean proportion for the two previous months was exceptionally low for the season of the year.

The general result referred to above, as to the small extent of increased proportion of organic carbon in the Thames-derived supplies furnished during the past month, is confirmed by the results of the determination of the amounts of oxygen required to oxidise the proportions of organic matter present, and of the determinations of the degree of colour-tint of the water. That the general influence of the floods was thus inconsiderable is a testimony of some value as to the efficiency of the subsidence and filtration works of the Companies.

The influence of the condition of the river upon the water-supply is, however, made more apparent by comparing with one another the results of individual examinations made during the past and previous months respectively. Thus, during the past month, in seven instances the proportion of organic carbon was found to exceed 0·170 part in 100,000 parts of the water, giving a mean of 0·180 part; whereas during the previous two months of the year the proportion of 0·170 was exceeded in two instances only, both occurring in the month of January, when the two highest proportions for the month were found to be 0·173 and 0·188 part respectively.

The maximum proportion of organic carbon present in any one sample of Thames-derived water examined during the past month was 0·193 part in 100,000 parts of the water, equivalent to about 0·340 grain of organic matter per gallon, or to about the $\frac{1}{1000}$ part of one per cent.

During the past quarter of the year we have examined 533 samples of the water furnished by the London Water Companies taking their supply from the Thames and the Lea. With two exceptions only, met with during the past month and recorded as "very slightly turbid," the whole of these samples were found to be well filtered, clear, and bright; while the mean proportion of organic carbon present in the Thames-derived samples examined was 0·157 part in 100,000 parts of the water, the three highest proportions being 0·188 part met with in a January sample, and 0·188 part and 0·193 part met with in two of the March samples.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES.
WILLIAM ODLING.
C. MEYMOTT TIDY.

A SIMPLE METHOD OF DETERMINING EQUIVALENTS FOR USE WITH LARGE CLASSES OF STUDENTS.

By JOSEPH TORREY,
Professor of Chemistry in Iowa College.

I DO not think it advisable, generally speaking, to introduce students to equivalents, atoms, molecules, &c., until they are pretty well advanced and tolerably expert analysts. The first term's work in this Laboratory is always on the metals, and the aim of the work is to accumulate results as rapidly as possible, and to familiarise the student with as many substances as possible. I believe this to be a method that prepares the mental system for theory when the time comes for it. While the freshman class were studying the action of hydrochloric acid on metals, it was noticed by some of them that some metals apparently liberated more hydrogen than others. This observation aroused considerable interest, and I thought it would be well to introduce the equivalent then and there.

The question was put as follows:—*What weight of each metal will it take to liberate one milligramme of hydrogen?*

The metals chosen for experiment were iron, zinc, and aluminium. The apparatus given to each student consisted of a 3-inch evaporating dish and a common 6-inch test-tube. In some cases graduated gas tubes were given out. 50 to 100 m.grms. of the metal having been accurately weighed, the test-tube was filled with acid (in most cases hydrochloric acid), and inverted in the evaporating dish, previously one-third filled with the same acid. The piece of metal was now quickly brought under the tube, and the whole apparatus left to itself till the solution was complete. Sometimes a gentle heat was applied. Later on it was found better to put the metal in a little cup (made by cutting off ½ inch from the lower end of a small test-tube) before bringing it under the tube, thus avoiding the possibility of bubbles being carried out by the descending current of acid. When solution was complete the tube was transferred to a large jar of water and the acid displaced by water. It was then cooled to the temperature of the room.

When graduated tubes had been employed the volume could then be read directly, the necessary corrections for temperature and pressure made, and the equivalent deduced. When ordinary test-tubes had been employed,

the line where gas ended and water began was marked on the tube by tying a piece of fine thread round it. Water was then run in from a carefully graduated burette till the space previously occupied by gas was occupied by water. The volume thus obtained represented the volume of gas obtained, and was corrected for temperature and pressure as usual.

I acknowledge the apparent crudeness and roughness of the process, but invite attention to the following results:—

Iron.	Zinc.	Aluminium.
28·2	32·68	9·006
27·8	32·65	9·004
27·69	32·46	9·004
27·78	32·36	9 000
27·74	32·52	9·000
27·75	32·40	9·03
27·93	32·60	8·995
28·03	32·45	8·988
28·11	32·48	9·07
27·90	32·35	8·887
27·89	32·50	9·100
27·80	32·39	9·12
27·85	32·22	9·010
27·97	32·62	
	32·46	

In some cases duplicate results are given, but where two results are identical they are given because they were separate results obtained by different students.

In such a crude process there are so many apparent sources of error that space would forbid a discussion of them, and I will only say that I believe the small quantities operated on cause many errors to vanish. The materials were all the purest obtainable. Great care was taken in marking and reading volumes. When heat had been used, and indeed in almost every case, the tube was —after the acid had been displaced by water, as previously stated—shaken so as to absorb most of the hydrochloric acid volatilised. The gas was usually allowed to stand for some time before being read. The burettes had been carefully compared with a calibrated standard, and any error in any one of them was not large enough to have affected the results materially.

There is of course nothing new about the process, but I have never seen any published results of its use with large classes.

Most of the work as to finding the best way of carrying out the process has been done by my Freshman class, some of whom have attained considerable skill in working it. The process as here presented is the best we have done so far.

When graduated tubes were employed the results were not as good. I think it was because the volume of gas and quantity of metal were great enough to be more appreciably affected by the inherent errors of the process. It should be said that the level of the water in the tube was always brought to the level of the water in the jar before reading the volume, and that the tube was left standing long enough to get to the temperature of the room after being placed in position.—*American Chemical Journal*, Vol. x., No. 1.

Active Crystalline Matter of the Poisoned Arrows of the Somalis, extracted from the Wood of the Ouabaio.— M. Arnaud.— The principle in question, ouabaine, forms rectangular plates, very slender, of a nacreous appearance. It is absolutely white, inodorous, and not appreciably bitter. It contains no nitrogen and does not react with colouring-matters. At a boiling heat, in presence of dilute acids, it is split up, yielding a reductive sugar. Its composition is $C_{30}H_{45}O_{12}$. It is poisonous if introduced into the circulation, but not if swallowed.—*Comptes Rendus*, Vol. cvi., No. 14.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, April 19th, 1888.

Mr. William Crookes, F.R.S., President, in the Chair.

Mr. James H. Gardner was formally admitted a Fellow of the Society.

A certificate was read in favour of Mr. George Thomas Evans, The Terrace, Rhymney, Mon.

The following were elected Fellows of the Society:—Ludwig Claisen, Ph.D.; Joseph Cowper; William Henry Dodd; John Gill; Frederick Preston de Jong; Thomas Enracht Lindsay, B.A.; Henry John Palmer; Eugene MacSwineef; John George Taylor; John Cecil Watson; Thomas Howell Williams; James Woodward.

The following papers were read:—

29. "*The Influence of Temperature on the Composition and Solubility of Hydrated Calcium Sulphate and of Calcium Hydroxide.*" By W. A. Shenstone and J. Tudor Cundall.

The authors have with great care re-examined the effect of heat on hydrated calcium sulphate. They have experimented on specimens of natural as well as on others of artificial origin, and they find, contrary to the usual statements on the subject, that hydrated calcium sulphate parts with a portion of its water at moderate temperatures, *e.g.*, 40° C., and that it may be almost completely dehydrated in dry air at temperatures below 100° C. Thus a specimen of selenite heated at 70° C. for 36 hours lost 20·14 per cent of water. The effect of heat in diminishing the solubility of calcium sulphate in water at temperatures between 40° C. and 150° C. may therefore possibly be due to the unequal solubility of the hydrated and anhydrous salts.

It is pointed out that the divergent statements made on this subject by various experimenters may be ascribed to the facts:—(1) That at temperatures below 100° C. the dissociation of hydrated calcium sulphate proceeds at first very slowly, so that in an experiment continued for a short period only the effect of heat may very easily be overlooked; and (2) that specimens of hydrated calcium sulphate of diverse origin do not always behave in the same manner under identical treatment.

The authors have not yet found any evidence of the dissociation of calcium hydroxide at moderate temperatures, even by extremely delicate and very prolonged experiments. This has led them to re-examine the influence of heat on the solubility of this compound, because previous experiments have, so far as they are aware, been made in glass vessels, which, as recent experiments have shown, may have been attacked. They find that when a saturated solution of calcium hydroxide is heated at 150° C. in a platinum tube for some hours, the resulting solution contains only 1 part of hydroxide in 3081 parts of water. There is therefore no doubt that this substance is less soluble in hot water than in cold. But there seems to be no evidence at present in favour of the view that in this case diminished solubility also may depend upon the dissociation of the hydroxide, or of some hydrate of the hydroxide.

30. "*Thermo-chemical Constants.*" By S. U. Pickering.

Heats of neutralisation, the differences between the heat of formation of similar salts of different metals, and the amounts of heat evolved on the introduction of the same radicle into various members of homologous series are often expressed by constant values the meaning of which may be easily understood; but Thomsen (*Thermochem.*, ii.,) has also drawn attention to the fact that in many cases the heats of formation of analogous compounds, or the differences between their heats of formation, are multiples of constants. Thus:—

$$P_2,O_5 = 5 \times 73,980$$
$$As_2,O_5 = 3 \times 73,130$$
$$As_2,O_3 = 2 \times 77,330$$

The existence of such a relationship, the author contends, can have no possible meaning, and he accounts for the occurrence of such coincidences as being simple mathematical chances. Given a certain number of quantities, it is easy to calculate the chances against any two of these being multiples of some constant, allowing a certain latitude for error, which allowance, it may be mentioned, attains considerable dimensions in many of the cases quoted by Thomsen.

Taking each case in which an analysis of this description is possible, it is shown that there is a sufficient number of data to supply the coincidences observed by Thomsen.

He also criticises Thomsen's supposition as to the existence of a "common constant of affinity," a quantity the multiples of which by numbers up to 10 are supposed to represent various interactions, some of which are similar and others totally dissimilar (*Ber.*, v., 170; vi,, 239). This constant Thomsen takes as being 18,631 cals.; but the author contends that any other number taken at random would have given similar results. Taking, for instance, 15,000 cals., he finds that, out of the data quoted in Thomsen's second and third volumes, as many as 120 quantities are multiples of this number within the limits of error allowed by Thomsen; and out of these we may select a large number which represent actions just as analogous as many of those quoted by Thomsen. For instance—

$$P,Cl_5 = 7 \times 14,998,$$
$$PCl_3,Cl_2 = 2 \times 14,845,$$
$$Ag,Cl = 2 \times 14,690,$$
$$K,Cl = 7 \times 15,087,$$
$$Mg,Cl_2 = 10 \times 15,101,$$
$$K,Br,Ag = 6 \times 15,038,$$
$$Zn,Br,Ag = 6 \times 15,160,$$
$$Sr,S,Ag = 7 \times 15,241,$$
$$Ca,I_2,Ag = 9 \times 14,993,$$

31. "*The Action of Hot Copper on the Mixed Vapours of Phenol and Carbon Disulphide.*" By Prof. Carnelley and John Dunn, University College, Dundee.

When a mixture of phenol and carbon disulphide is passed over hot copper a new diphenylene ketone, melting at 83°, is obtained isomeric with the diortho-ketone melting at 84°, already known, the interaction being—

$$2C_6H_5{\cdot}OH + CS_2 + 4Cu = 2Cu_2S + H_2O + C_6H_5{\cdot}CO{\cdot}C_6H_5$$
$$= 2Cu_2S + H_2O + H_2 + \cdot\begin{matrix} C_6H_4 \\ C_6H_4 \end{matrix}\!\!>\!CO.$$

Even under favourable circumstances the yield only amounts to about 1 per cent of the total mixture employed, as by far the greater portion (about six-sevenths) of the phenol passes over unchanged.

32. "*Oxidation of Oxalic Acid by Potassium Dichromate.*" By Emil A. Werner.

In this paper the author gives the results of an exhaustive study of the interactions of potassium dichromate and oxalic acid under different conditions and in varying molecular proportions. The results obtained are different from those described by Mr. Bothamley in a recent communication on the above subject (*Chem. Soc. Trans.*, 1888, 159), and may be summed up in the following conclusions:—

1. The red potassium dichromoxalate,—

$$K_2H_2C_2(C_2O_4)_4(OH)_2 \text{ (Croft's salt)},$$

is in all cases, *without exception*, a product of the interaction of potassium dichromate and hydrated oxalic acid below 200° C.

2. Neutral potassium chromate is *never* present as a product of the interaction of potassium dichromate and oxalic acid under any conditions below 200° C.

3. When the two compounds interact in the solid state, the initial temperature of the interaction, which lies between 30° and 60°, varies with the molecular proportions employed.

4. The dehydration of the oxalic acid does not affect the nature of the interaction, the anhydrous chromoxalate, $K_2Cr_2(C_2O_4)_4$, being formed in this case.

5. Water, by its solvent action, facilitates the interaction, *i.e.*, reduces the initial temperature, but is otherwise without influence on the nature of the change.

6. Seven molecules of oxalic acid is the *minimum* quantity necessary for the complete reduction of 1 mol. of potassium dichromate, and *any excess of either above this ratio remains unchanged.*

7. When the proportion of potassium dichromate to oxalic acid exceeds 1 mol. to 7 mols., and the temperature of the mixture is raised to low redness, a secondary interaction occurs between the excess of dichromate and the red chromoxalate first formed.

33. "*The Action of Phenylhydrazine on Urea and some of its Derivatives.*" By Sidney Skinner, B.A., and S. Ruhemann, Ph.D.

The authors give an account of the action of phenylhydrazine on certain compounds nearly related to urea, describing several substances which complete the series of semicarbazides and carbazides both of oxy- and thiourea, *e.g.*, diphenylcarbazide $CO(NH{\cdot}NH{\cdot}Ph)_2$, from phenylhydrazine and ethylic carbamate or urea; and diphenylsemicarbazide, $Ph{\cdot}HN{\cdot}CO{\cdot}NH{\cdot}NH{\cdot}Ph$, from phenylurea and phenylhydrazine. The compounds which contain two directly-linked nitrogen-atoms are found to exhibit a characteristic behaviour with mild oxidising agents—cupric sulphate and mercuric chloride—yielding coloured compounds; and in this respect they differ in a marked manner from urea. Biuret and phenylhydrazine interact to form ammonia and Pinner's phenylurazole. In the latter part of the paper the action of phenylhydrazine on parabanic acid and on alloxan is considered.

34. "*Derivatives of Phenylisobutyric Acid.*" By L. Edeleanu, Ph.D.

The derivatives described are paranitrophenylisobutyric acid, m. p. 121°; orthonitrophenylisobutyric acid, an oil; parorthodinitrophenylisobutyric acid, m. p. 89°, and its methylic salt, m. p. 76°; nitroamidophenylisobutyric acid, m. p. 138°; amidomethylhydrocarbostyril, m. p. 216°: the last-mentioned being obtained by complete reduction of the dinitro-acid.

35. "*The Logarithmic Law of Atomic Weights.*" By G. Johnstone Stoney, F.R.S.

A verbal explanation was given of a paper on this subject, which the author had that day given at the Royal Society.

The following lectures will be given on Wednesday afternoons, at 4 P.M., under the auspices of the College of State Medicine:—

May 2. "The Aims and Objects of State Medicine." By R. Brudenell Carter, F.R.C.S.

May 16. "Soil in its Influence on Health." By Professor H. G. Seeley, F.R.S.

May 30. "The Organisms occurring in Fresh Water, and the Hygienic Importance of their Presence." By Inspector-General John M. Macdonald, M.D., F.R.S.

June 13. "Some of the more Important Diseases Common to Man and Animals." By G. Fleming, Esq., LL.D., C.B., &c.

June 27. "The Rise and Progress of Sanitary Engineering within the Present Century." By Sir Robert Rawlinson, K.C.B.

July 11. "Responsibility and Disease." Sir J. Crichton Browne, M.D., LL.D.

Fellows of the Chemical Society who may be interested in the lectures are invited to attend.

At the next meeting on May 3rd the following paper will be read:—

"The Determination of the Molecular Weight of the Carbohydrates." By Horace D. Brown and E. H. Morris, Ph.D.

NOTICES OF BOOKS.

Watts's Dictionary of Chemistry. Revised and entirely Re-written by H. Forster Morley, M.A., D.Sc., Fellow of and late Assistant Professor of Chemistry in University College, London, and M. M. Pattison Muir, M.A., Fellow and Prælector in Chemistry of Gonville and Caius College, Cambridge; assisted by Eminent Contributors. In Four Volumes. Vol. I. London: Longmans, Green, and Co.

Any attempt to describe or to criticise "Watts's Dictionary of Chemistry" would be looked on as a very needless, if not a foolish undertaking. But in chemistry, more than in any other science, there are a number of "vera troublesome persons" who will persist in carrying on researches, revising and modifying the conclusions of their predecessors, and extending the boundaries of our knowledge. So rapid has been this process that, although only twenty-five years have gone by since the first part of the "Dictionary" appeared, a new edition has become necessary. Of this Mr. Watts was fully aware; he had taken the task in hand, and at the time of his lamented death he had written about sixty-three pages of the work as it now appears, and had issued instructions to his collaborators.

The undertaking has therefore been committed for completion to Dr. H. F. Morley and Mr. M. M. Pattison Muir, both of whom are well qualified for the task, as they have proved by the volume now before us. The plan of the work has been modified in several respects. Instead of eight volumes, besides the Supplements, the present edition will extend only to four, of 750 pages each. To render this reduction in bulk practicable certain changes have been made, which are in themselves by no means disadvantageous. The old edition was entitled "A Dictionary of Chemistry and the Allied Branches of other Sciences," whilst the present work is confined to chemistry only. Perhaps it may be questioned whether the articles "Bacteria" and "Blood," in the volume before us, are not to some extent a transgression of these limits.

An additional quantity of space is gained by the omission of the articles on chemical arts and manufactures. Such subjects will be taken up in a separate volume under the able editorship of Prof. T. E. Thorpe.

Analytical chemistry, beyond a general summary of the principles of this art and of its leading methods, has also been eliminated. An exception—concerning the propriety of which we are very doubtful—has been made in favour of arsenic, the detection and determination of which are given at considerable length. Lastly, room has been economised by the use of abbreviations. Formulæ, we are told, "are frequently employed instead of names to save space." Formulæ we must, however, remember are not necessarily briefer than names, of which instances might be found without great difficulty.

The space thus economised is required for a notice of the many additions made to chemical science since the appearance of the original edition, and, secondly, for an account of the leading physical methods of investigation used in chemistry, and of the chief results obtained.

The work of the two editors is distinctly separated. Dr. Morley has superintended the organic and Mr. Muir the inorganic portion. The list of contributors is such as to inspire the reader with confidence. We find that Mr. C. F. Cross undertakes cellulose; Prof. Dittmar, the general article on analysis; Mr. A. G. Green, the diazo-compounds; Dr. J. J. Hood, chemical change; Dr. W. D. Halliburton, blood; Prof. F. R. Japp, benzil, its ammonia derivatives, the corresponding derivatives of benzoic aldehyd, and benzoin. Prof. E. Ray Lankester furnishes an able article on bacteria; Prof. L. Meyer, of Tubingen, allotropy; Prof. Raphael Meldola, the azo-colouring-matters; Prof. W. Ostwald, affinity; Prof. Plimpton, amylamines; Prof. W. Ramsay, acids and alloys; Mr. C. O'Sullivan, arabic acid, bassorin, and cerasin. Dr. Stevenson contributes detection and estimation of poisonous alkaloids: this article, though in itself of undoubted merit, seems to us not in accordance with the determination of the editors, as expressed in the Preface, to omit "details regarding analytical processes." Prof. J. J. Thomson contributes states of aggregation; Prof. T. E. Thorpe, atmosphere; Mr. Warington, ash of organic bodies; Mr. C. J. Wilson, caoutchouc; whilst the first portion of alcohols and various special articles are from the pen of the late Mr. Watts.

After a careful examination we feel convinced that this second edition will be found indispensable by every chemist who desires to have at hand a complete and accurate summary of the present state of his science.

Elementary Chemistry, Inorganic and Organic. By W. S. Furneaux, F.R.G.S. London: Longmans, Green, and Co.

This work, which is one of "Longmans' Elementary Science Manuals," is "adapted to the requirements of of the alternative elementary syllabus of the Science and Art Department." The author hopes, however, that his treatise may also be found useful to persons who are seeking not to "pass," but to "know." We may well suppose that in a work which undertakes to discuss inorganic and organic chemistry within the compass of 150 small pages details cannot be expected. Errors, however, are absent, as it might be expected, and in very few instances only are facts expressed in such a manner as to lead the inexperienced reader astray. We might, of course, object to such statements as that nitric acid "bleaches" indigo, and that the aniline colours are produced by the "distillation" of tar. But if we were asked to state distinctly what advantage this manual presents over many others which have appeared within the last few years, we should feel at a loss. The number of elementary treatises issued in England is a perfectly exceptional feature in our scientific literature as compared with that of other countries.

The Geological Record for 1879. An Account of Work on Geology, Mineralogy, and Palæontology, published during the Year. With Supplements for 1874 to 1878. Edited by W. Whittaker, B.A., F.G.S., and W. H. Dalton, F.G.S. London: Taylor and Francis.

To find a work summarising the results of observation and discovery appearing eight years after date may well stagger the reader. We cannot do other than accept the apology tendered by Mr. Whittaker, that the work of contributors, sub-editors, and editors is unpaid. We must regret that such an arrangement should be necessary. We must further regret that the encroachments which the "tendencies of the age" are making upon the leisure of scientific men render unpaid work of a good quality hard to be obtained.

We learn, further, from the Preface, that in order to bring the Record up to date the mere titles only of the memoirs, &c., will in future be given, without any abstracts. This curtailment, though we fear necessary, will greatly interfere with the value of the Record.

Proceedings of the American Pharmaceutical Association at the Thirty-fifth Annual Meeting: held at Cincinnati, September, 1887. Philadelphia: The American Pharmaceutical Association.

These "Proceedings" commence with a report in which it is judiciously urged that progressive pharmacists should

direct their efforts towards "sweeping from the field of pharmacy all those sailing under a trade-mark, or for which a working formula is withheld.

Under "Report on the Progress of Pharmacy" we find a collection of abstracts, some of them dating back as far as 1886, and by no means entirely confined to pharmacy.

Among the minutes of the Section on Scientific Papers we find a discussion on the comparative merits of genuine vanilla and of the vanilline manufactured from pine-cones or from eugenol. The conclusion was that, to an experienced person, there is something unpleasant about the artificial product.

CORRESPONDENCE.

NEW ELEMENTS.

To the Editor of the Chemical News.

Sir,—In the Chemical News (vol. liv., p. 167) there is an article by Mr. Alexander Pringle entitled, "On Some Probable New Elements." With some of your other readers may I ask the author to inform us if he has done anything further in isolating the remarkable bodies therein mentioned. I am at present engaged in a similar investigation, and naturally am anxious to assure myself that the substance under my notice has not been isolated before.—I am, &c.,

A. E.

April 19, 1888.

THE USE OF THE TERMS "ANALYSIS" AND "ASSAY."

To the Editor of the Chemical News.

Sir,—In support of their contention that the term "assay" should be limited to furnace operations conducted on metals and their ores, your correspondents Messrs. Teschemacher and Smith quote an article by the late Mr. Richard Phillips, published in the "Penny Cyclopædia" of 1833, in which a definition of the word "assay" is given, with which I perfectly agree.

But, as I pointed out in my last letter, furnace operations were those which first attained to approximate quantitative accuracy, and in 1833 almost the only substances admitting of being, or, at any rate, requiring to be, commercially assayed, were metallic ores and metallurgical products, if we except the examination of alcoholic liquors by the Excise. The same argument applies still more strongly to the use of the term by Berthier, though even he employs the adjective *dry* in conjunction with the word "assay."

But as Messrs. Teschemacher and Smith have raised the ghost of the late Mr. Phillips, and apparently regard his article published in 1833 as binding on the present users of the term "assay," I may be allowed to point out that in J. A. Phillips's "Elements of Metallurgy," published in 1874, I find a section on "The Dry Assay of Iron Ores," and another on "The Wet Assay of Iron Ores"; an article on "The Cornish Dry Assay," and another on "The Wet Assay of Copper Ores"; a section under Zinc Ores headed "Fire Assay," and another "Volumetric Assay." Similarly the "Fire Assay" and the "Humid Assay" of silver bullion are duly described. I need not multiply these references, but may simply state that Percy and other metallurgists employ the term "assay" in an equally extended sense.

Remembering the origin and meaning of the word "assay," it is strange that an attempt should be made to limit its signification to the examination of ores and metallurgical products. At any rate, the term is now so widely used that I am afraid chemists will be unwilling to abandon its application to various commercial products, such as pyrites, bleaching-powder, starch, anthracene, opium, tannin-matters, disinfecting powders, &c., &c. Nevertheless, this is a free country, and no one who has found the extended use of the term "assay" useful in the foregoing and similar instances will desire to prevent Messrs. Teschemacher and Smith from restricting their own employment of it to a series of operations which, except for gold and silver determinations, are now almost obsolete.

On precisely the same grounds that Messrs. Teschemacher and Smith object to the present extended use of the word "assay" they might logically resent the habitual application of the words alcohol, ether, ammonia, to bodies of the general character of their respective prototypes.—I am, &c.,

Alfred H. Allen.

Sheffield, April 21, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of emperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 14, April 3, 1888.

The Relations of Atmospheric Nitrogen to Vegetable Mould.—Th. Schlœsing.—The author thinking that the vapours of the mercury used in measuring the air in his first series of experiments might possibly have killed the microbia present, has repeated them with the exclusion of mercury. The results, however, were similar. Whether mercurial vapour was present or absent the quantities of nitrogen which might be supposed to be fixed are too minute to be measured by the most sensitive procedures.

Manufacture of Farmyard Manure.—P. P. Dehérain.—The black matter of the manure is produced firstly by the solution, aided by alkaline carbonates of the vasculose and the albumenoids of the straw and of the nitrogenous matter contained in the excreta of live-stock, and secondly by the transformation of the ammonia into organic matter, a change due to the vital activity of the ferments.

Sophistications of Olive Oils. — R. Brulle. — The author places in a test-tube 0·1 grm. of albumen in powder, 2 c.c. of nitric acid and 10 c.c. of the oil in question, and heats so that the acid and the oil are of the same temperature. The tube is held so that the oil and the albumen may become mixed. If the olive oil is pure the colour of the mixture is of a greenish yellow; if the oil is mixed with 5 per cent of a seed oil the shade is a distinct amber-yellow, darker as the impurity increases. This method does not, however, detect the oil known in commerce as "exotic aveline."

Detection of Impurities in Industrial Alcohols.—L. Godefroy.—The author pours into a test-tube 6 to 7 c.c. of the alcohol in question, adds a single drop of absolutely pure crystallisable benzene, shakes; adds 6 to 7 c.c. of pure sulphuric acid at 66° B., and shakes again. If reductive compounds are present more volatile than ethylic alcohol there appears a colour varying from light brown to black. If the alcohol is chemically pure there appears, in eight to ten minutes, a slight rose colour. If the mixture remains colourless it is boiled for a few minutes, when, if compounds less volatile than ethylic alcohol are present, it takes, on exposure to light, a distinct brown colour with a green fluorescence.

Bulletin de la Société Chimique de Paris. Vol. xlviii., No. 12, December 20, 1887.

The Inactose of Neutral Sugar.—E. J. Maumené.—The author, in 1870, obtained inactose, a sugar optically

inactive, by treating normal sugar with silver nitrate. Inactose does not crystallise, and does not reduce the cupro-potassic solution.

Method for obtaining Definite Hydrates.—MM. Maumené and C. Limb.—The authors hold that crystals should not be dried indifferently over lime, sulphuric acid, or phosphoric acid, especially in a vacuum. They left a quantity of very pure crystals of oxalic acid for six months under a bell along with oxalic acid dried by heat. The crystals gave, on analysis, $C_2HO_4(HO)_2$. Similar crystals dried for six months over sulphuric acid gave exactly C_2HO_4.

Action of Glacial Acetic Acid upon Citrene.—J. Lafont.—The products of the reaction in heat are a dextro-rotatory citrene acetate, which, on saponification, yields a dextro-rotatory terpilenol.

Action of Formic Anhydride upon Camphene.—J. Lafont.—The combination of formic acid with the camphenes is effected with such ease that it may be used for their transformation into camphors.

On Trichloric Alcohol, and the Action of Zinc-ethyl upon the Aldehyds.— Maurice Delacre. — On causing chloral to act upon zinc-ethyl in equal mols. in presence of a sufficiency of ether a few crystals are deposited, an intermediate product between zinc-ethyl and trichloro-zinc alcoholate.

On Allene.—A. Béhal.—This extensive paper is not adapted for usefnl reproduction.

The Characters of the Secondary Aromatic Diamines containing an Ethylenic Grouping.—Albert Coulson.—The ethylene diphenylamine of Hofmann has no action upon phenol-phthalein, whilst it reacts easily with methyl orange (orangé No. 3 of Poirrier). This character is common to many bases of the same family, but it decreases notably as the molecular weight increases. If the hydrochlorate or the hydrobromate of the aromatic base is treated with sodium nitrite at 0° we have a yellow precipitate fusible about 90°. If the precipitate on being brought in contact with phenols in an alkaline solution does not produce colouring-matters it is a nitroso- and not an azo-derivative, and the base in question is a secondary amine.

Study of the Alcohols produced in the Fermentation of Glycerin by Bacillus Butylicus. Formation of Normal Amylic Alcohol.—E. Charles Morin.—In this fermentation normal amylic alcohol is produced at the expense of the glycerin along with ethylic, propylic (normal), and butylic (normal) alcohols.

New Apparatus for Fractionated Distillation.—E. Claudon and E. C. Morin.—This paper requires the two accompanying cuts and the diagram.

Zeitschrift fur Analytische Chemie.
Vol. xxvi., Part 4.

The Boiling Temperatures of Saline Solutions and Comparisons of the Rise of the Boiling-points with the other Properties of such Solutions.— Dr. G. Th. Gerlach.—A voluminous treatise which cannot be reproduced without the numerous tables and the eight accompanylng plates.

Determination of Metallic Iron in Slags.—G. Neumann.—The author criticises the existing methods and proposes a new process, turning on the use of an apparatus here figured.

Testing Indigo-dyes.—W. Lenz.—The author deals with the question whether a sample of goods is dyed with indigo alone or with a mixture of indigo and other blue colouring-matters His method may be summarised as follows:—Threads of the material in question should give up no colouring-matter to boiling water. Alcohol at 50 and at 95 per cent (by volume) ought to extract no colour, even if gently warmed (not boiled). Solution of oxalic acid saturated in the cold, solution of borax, solution of alum at 10 per cent, and solution of ammonium molybdate at 33⅓ per cent ought not to extract any colouring-matter at a boiling heat. The borax extract, if subsequently treated with hydrochloric acid, should not turn red nor become blue on the further addition of ferric chloride. Solutions of stannous chloride and ferric chloride with the aid of heat ought entirely to destroy the blue colouring-matter. Glacial acetic acid on repeated boiling should entirely dissolve the colouring-matter. If the acetic extracts are mixed with two volumes of ether and water is added, so as to separate out the ether, the water should appear as a slightly blue solution, the main bulk of the indigo remaining in suspension at the surface of contact of the ethereal and watery stratum. This acid watery stratum should be colourless, and should not assume any colour if a little strong hydrochloric acid is allowed to fall into it through the ether. No sulphuretted hydrogen should be evolved on boiling the yarn or cloth in strong hydrochloric acid. On prolonged boiling, supersaturation with strong potassa in excess, heating, and adding a few drops of chloroform, no isonitrile should be formed.

Detection of Aniline Dyes in Red Wines, Fruit Juices, &c.—C. O. Curtman.—The author detects these colours by means of Hofmann's well-known isonitril reaction.

MEETINGS FOR THE WEEK.

MONDAY, 30th.—Medical, 8.30.
— Society of Arts, 8. "Decoration," by G. Aitchison, A.R.A.
TUESDAY, April 1st.—Institution of Civil Engineers, 8.
— Pathological, 8.30.
— Royal Institution, 3. "The Plant in the War of Nature," by Walter Gardiner. M.A. (Annual Meeting at 1.30 p.m.)
WEDNESDAY, 2nd.—Society of Arts, 8. "Drawing, a Means of Education," by T. R. Ablett.
THURSDAY, 3rd.—Royal, 4.30.
— Royal Society Club, 6.30.
— Royal Institution, 3. "The Chemical Arts," by Professor Dewar, M.A., F.R.S.
— Chemical, 8. "The Determination of the Molecular Weights of the Carbohydrates," by Horace T. Brown and G. H. Morris, Ph.D. "The Action of Heat on the Salts of Tetramethylammonium," by N. Collie and Dr. Lawson. "The Action of Heat on the Salts of Tetramethylphosphonium," by N. Collie.
FRIDAY, 4th.—Geologists' Association, 8.
— Royal Institution, 9. "The Invincible Armada: A Tercentenary Retrospect" by J. K. Laughton, M.A., R.N.
— Society of Arts, 8. "The Injurious Effects of Canal Irrigation on the Health of the Population of the Punjab," by Surgeon-General H. W. Bellew, C.S.I., C.I.E.
SATURDAY, 5th.—Royal Institution, 3. "The Later Works of Richard Wagner," by Carl Armbruster.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Market Value of Gas.—If the market value of a 16 candle gas be 2s. per 1000 cubic feet, what ought to be the value of an 18 candle gas per 1000 cubic feet? This question has been put on the assumption that the value is not in direct proportion to the illuminating power. The observations of anyone with commercial data at command would be of interest.—ANALYST.

Analysis of Bad Waters.—J. H. Smith (*Jour. Soc. Chem. Ind.*, April, 1887, p. 262) asserts that an alkaline solution of potassium permanganate may be boiled easily, but if any MnO_2 be present violent concussions occur. It would thus appear that "bumping" will only occur in Wanklyn's process for the determination of "albumenoid" ammonia, if the water be sufficiently bad to reduce any of the potassium permanganate to MnO_2. This affords an explanation of a fact which has often proved at the same time a trouble and a puzzle.

Earrings of Lead.—(Reply to W. T.).—Lead has not any active chemical healing properties. The Russian ladies are governed in using earrings of lead by German jewellers, who make rings thereof—being considered very painless—to bore ears with; but Muscovite ladies never wear earrings of lead. These rings are removed after a few days, when the holes are perfectly healed, and ear-wires of gold always substituted for general wear. Lead is too soft for earrings and is apt to break.—MARY SHOONEN.

Goldsmith's Hall Mark and Gold Ear-Wires.—What is the reason that English gold ear-wires are never stamped with the Hall-mark? Persons who purchase such rings are always obliged to trust the shopmen as to proper legal weight of wires, which fashion has indeed made the tone even throughout all hemispheres. Does 24-carat gold ever exist in British ear-rings? I am perfectly aware that weight is legal tender for our sovereign. Any information will much oblige.—MARIA TIBUS.

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By Order,
WILLIAM E. VINSON,
Secretary.

Gas Offices, Gloucester,
April 13th, 1888.

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THE CHEMICAL NEWS.

Vol. LVII. No. 1484.

PRESERVATION OF SULPHURETTED HYDROGEN SOLUTION IN THE LABORATORY.

By DAVID LINDO.

As a solution of sulphuretted hydrogen in a mixture of glycerin and water is quoted on the price-lists of chemical reagents published by some houses, I infer the preparation is employed in laboratories.

According to a statement published in the Chemical News (vol. xv., p. 218), the suggestion to saturate dilute glycerin, instead of pure water, with the gas, originated with M. Lepage, of Gisors, who alleges the solution so prepared will keep for twelve or fifteen months, with scarcely any loss of strength.

It is stated that the dilute glycerin dissolves less of the gas than distilled water: representing the solubility in the latter liquid by 100, that in the former will be 60. It is also said that glycerin prevents solution of ammonium sulphide from becoming yellow.

In this paper I have recorded the results of experiments undertaken to ascertain if there is really any advantage in using the solvent for the gas, proposed by Lepage, instead of distilled water.

I have not found that glycerin prevents solution of sulphide of ammonium from becoming yellow.

The first requisite in pursuing an enquiry of this kind is a rapid and accurate method for estimating the strength of the gas solutions. For aqueous and *recently* prepared dilute glycerin solutions, as well as for some others tried, I know of no better process than precipitating with silver nitrate in presence of excess of ammonia, and weighing. Such a method, however, would not be rapid if a paper filter were employed, since the precipitate and filter would either have to be dried at 100°—a tedious proceeding, and not likely to give accurate results—or the whole would have to be burnt and reduced in a current of hydrogen.

By using Gooch's method of filtration the process is rendered expeditious and accurate.

I employ as reagents a solution of silver nitrate containing 1 grm. of the salt in 20 c.c., and a 6 to 7 per cent solution of ammonia. The quantity of gas solution used for each test may be 5 or 10 c.c., according to the strength.

Five to 12 c.c. silver solution—according to the supposed strength of the gas solution and quantity to be tested—are placed in a small beaker, 10 c.c. water and 10 to 15 c.c. ammonia added, the gas solution measured with a pipette, and run in. Warming gently and stirring greatly facilitates subsidence of the precipitate, which is to be rubbed down with a glass rod, washed three or four times by decantation, transferred with a trimmed feather to the Gooch crucible, the washing completed, and a few c.c. of alcohol passed through. Dry on the water-bath. The precipitate, if pure, will contain 12·91 per cent sulphur.

I have compared the results with those obtained by reducing in hydrogen and weighing the silver.

First Experiment.—A weak aqueous solution of the gas taken. 10 c.c. precipitated and weighed as sulphide gave 0·0439 grm. = 0·00566 sulphur. 10 c.c. precipitated, filtered through pure paper, dried, burnt, and ignited in hydrogen, gave 0·0376 silver = 0·00557 sulphur.

Second Experiment.—Water saturated at low temperature, and the gas fixed by adding soda. 5 c.c. (at ordinary temperature) gave 0·1594 sulphide silver = 0·0206 sulphur. 5 c.c. gave by ignition in hydrogen 0·1382 silver = 0·0205 sulphur.

Third Experiment.—Camphored water at low temperature; gas passed, but not to saturation; fixed with soda. 5 c.c. gave 0·1376 sulphide = 0·0178 sulphur. 5 c.c. gave by ignition in hydrogen 0·1196 silver = 0·0177 sulphur.

Common camphor, boric acid, thymol in small quantity, have each been tried as preservative agents: the first and last appear to retard oxidation, but the solutions lose strength chiefly in consequence of the gas escaping from them, and none of these substances will check loss from this cause.

The gas in all such mixtures can be accurately estimated by the silver method, and also, as stated above, in dilute glycerin solutions, provided they are fresh; at least this is my experience with the samples of glycerin employed, which were of the best quality.

If the glycerin solutions, however, are kept for some time, fermentative change occurs, and the silver method is no longer available, the results coming out too high. In this case I precipitate with arsenious acid, using a solution of the acid in excess of sodic carbonate, followed by HCl in some excess, and weigh the orpiment after drying on the water-bath. The method is rather troublesome, and requires some practice, as the precipitate is difficult to wash. It retains traces of chlorides with immense force, and, if the washing is not arrested before the chlorine reaction quite ceases, the protracted exposure will cause sufficient loss by oxidation to lower the results sensibly. I used the Gooch method of filtration, and experienced no great difficulty with precipitates weighing not much over 0·030 grm., but without some device to render filtration more rapid precipitates weighing 0·050 to 0·070 grm. could not be managed. Fissures generally appear in the precipitate, and if these are allowed to remain open the water passes quickly, but does not wash the precipitate. If the cracks are closed with a glass rod the washing may occupy hours, and the result would then be worthless. I have washed these large precipitates in less than an hour, by adding about twice their supposed weight of prepared asbestos (prepared as for filtering) to the mixture to be precipitated before running in HCl. The orpiment, on adding the acid, goes down well mixed with the asbestos, forming a mass which does not crack on applying suction, and can be washed with comparative ease. The best plan, however, with strong solutions of the gas, is to take only 5 c.c. accurately measured, which will give a weight of orpiment not difficult to manage. The precipitate, if pure, will contain 39·02 per cent sulphur. Results, compared with those obtained by the silver method, are given in Table I., various solvents being used for the gas, and weak and strong solutions of the latter. 10 c.c. taken for each test.

Table I.

Solvent.	By silver, wt. of ppt. in grm. = S.	By arsenic, wt. of ppt. in grm. = S.
A. Water	0·2520 = 0·0325	0·0799 = 0·0312
B. Camphored water	0·2234 = 0·0288	0·0718 = 0·0280
C. Water and traces of thymol ..	0·0796 = 0·0103	0·0258 = 0·0101
D. (1) Water	0·1588 = 0·0205	0·0507 = 0·0198
(2) Water	0·1586 = 0·0205	— —
E. Glycerin and water, equal vols.	0·0967 = 0·0125	0·0310 = 0·0121
F. Camphored water	0·0439 = 0·0057	0·0140 = 0·0055
G. Water	0·0360 = 0·0046	0·0115 = 0·0045
H. Camphored water	0·0263 = 0·0034	0·0081 = 0·0032

Taking results by the silver method as correct, the experiments have shown that the arsenic method will give results on an average 3 to 4 per cent below the truth: a correction of 4 per cent will be made in future, which will

give results sufficiently accurate for all practical purposes. In experiments that follow the arsenic method has only been used in testing glycerin solutions not recently prepared.

The earliest results obtained seemed to indicate there was little or nothing to be gained by using a mixture of glycerin and water, instead of pure water, as a solvent for the gas. Oxidation is not prevented by the glycerin,—seems, on the contrary, to be rather increased by its presence; the solution soon becomes turbid, remains so for months, and deposits a good deal of sulphur. On the other hand, the gas does not escape so rapidly from a mixture of glycerin and water as it does from pure water; but if both are saturated at the start the aqueous solution will of course be the strongest, and experiments have shown it will remain so until the strength of both is considerably reduced.

Experiments.—Two reagent bottles were taken of the same shape, and about the same capacity; measuring to the bottom of stoppers No. 1 0·273 c.c., No. 2 0·278 c.c. In No. 1 placed 200 c.c. distilled water, in No. 2 200 c.c. of a mixture. Glycerin 4, water 5, by volume. Passed gas until both were thought to be saturated. Removed 5 c.c. from each with a pipette, and estimated strengths by silver. Temperature 25·6°, weights in grammes:—

No. 1. Water, 5 c.c. gave precipitate .. .. 0·1046=0·0135 S.
No. 2. Glycerin and water, 5 c.c. gave precipitate .. .. 0·0740=0·0096 S.

The stoppers were removed, and a cylindrical tin cover 8×9 ins. placed over the open bottles. Every two hours 5 c.c. were removed from each, and the strengths estimated. I have given the strengths after four hours and after ten hours, when both were so reduced that it was unnecessary to carry the experiment further.

After four hours. Temperature 27·8°:—
No. 1. Water, 5 c.c. gave precipitate .. .. 0·0658=0·0085 S.
No. 2, Glycerin and water, 5 c.c. gave precipitate .. .. 0·0600=0·0077 S.
After ten hours. Temperature 29°:—
No. 1. Water, 5 c.c. gave precipitate .. .. 0·0380=0·0049 S.
No. 2. Glycerin and water, 5 c.c. gave precipitate .. .. 0·0418=0·0054 S.

The solutions remained quite clear to the end.

2nd. The bottles were charged with fresh solutions, but reversed, No. 1 being used for the glycerin and water, and No. 2 for the aqueous solution. The strengths were estimated immediately after passing the gas; five hours after, and ten hours after, the bottles being kept under cover, with the stoppers out, as in the first experiment. Temperature 26·5°:—

No. 1. Glycerin and water, 5 c.c. gave precipitate .. .. 0·0820=0·0106 S.
No. 2. Water, 5 c.c. gave precipitate .. .. 0·1008=0·0130 S.

After five hours. Temperature 29·8°:—
No. 1. Glycerin and water, 5 c.c. gave precipitate .. .. 0·0556=0·0072 S.
No. 2. Water, 5 c.c. gave precipitate .. .. 0·0596=0·0077 S.

After ten hours. Temperature 30·1°:—
No. 1. Glycerin and water, 5 c.c. gave precipitate .. .. 0·0454=0·0059 S.
No. 2. Water, 5 c.c. gave precipitate .. .. 0·0356=0·0046 S.

Results of experiments made with closed bottles were not as favourable as the above for the glycerin mixture. As the average temperature here is high, there is considerable difficulty in conducting such experiments. Unless the stoppers are secured they are apt to jump out or get loosened from the internal pressure; reagent bottles with flat conical stoppers are quite unsuitable for the purpose. Without a lubricant no stoppers fit accurately enough to give even fairly concordant results with the same solution, and unless these can be secured it is obviously a waste of time to attempt comparative experiments between one solution and another.

The bottles used in the following experiments are made of very pale blue glass, and are the kind employed by manufacturers for putting up liquor ammonia and acids. I imported them with the stoppers ground with more than ordinary care, and used pure paraffin wax as a lubricant. Five were employed for aqueous solutions and four for glycerin: one of the latter unfortunately got broken before the experiments were completed.

The volume of liquid placed in each bottle was 530 c.c. A rapid current of gas was passed through the water in each bottle for forty minutes, though previous experiments had shown twenty minutes often sufficed to saturate this volume of water in a similar bottle at the average temperature of the Laboratory. The mixture of glycerin and water, 4 : 5 by volume, required a longer time for saturation.

The gas was passed forty minutes through the 530 c.c.; the materials for generating (sulphide of iron and dilute sulphuric acid) renewed, and the gas passed again for thirty or forty minutes. The strengths were estimated at once by removing 10 c.c. from each bottle with a pipette, and running into a small beaker containing the silver mixture.

The bottles were then closed with the waxed stoppers, all placed in the same cupboard, and securely wedged up up with books and folds of paper between two shelves.

Every week, for five weeks, 10 c.c. was carefully poured out of each and thrown away. Every six weeks 10 c.c. of the fluid, free from sediment, was removed with a pipette from each, and the strength estimated.

The bottles were charged 23rd to 26th May, 1887, and the experiments, continued as described above, without interruption, until August.

From an unavoidable cause I was obliged to leave the bottles undisturbed from August until near the end of October, when the experiments were resumed, and continued until February this year. The average temperature calculated for the whole period was about 26°, the highest record being 31·3° and the lowest 21·8°.

In the following Table I have given the capacities of the bottles with the stoppers in; deducting 520 c.c. in each case will give the air space in each bottle at the commencement, after removing the first 10 c.c. for estimation. I have given the strengths at the commencement and at the end of the experiments, which is all that it is necessary to give here.

Table II.

Aqueous Solutions.

Capacities of Bottles.	10 c.c. gave in May, '87, Silver ppt. = S.	10 c.c. gave in Feb., '88, Silver ppt. = S.
1. 562·5 c.c.	0·2008 = 0·0259	0·0569 = 0·0073
2. 571·0 „	0·1924 = 0·0248	0·0541 = 0·0070
3. 569·5 „	0·2012 = 0·0260	0·0688 = 0·0089
4. 556·5 „	0·2007 = 0·0259	0·0661 = 0·0085
5. 565·5 „	0·1980 = 0·0256	0·0606 = 0·0078

Glycerin and Water Solutions.

		Arsenic ppt. corrected.
1. 566·5 c.c.	0·1570 = 0·0203	0·0175 = 0·0068
2. 570·0 „	0·1598 = 0·0206	0·0180 = 0·0070
3. 569·5 „	0·1560 = 0·0201	0·0146 = 0·0057

These results seem clearly to show that there is nothing to be gained, at least in this climate, by using a mixture of glycerin and water, instead of pure water, as a solvent for the gas. A number of experiments had been made previous to the above, the results of which pointed to the same conclusion, but, doubting if sufficient precautions

had been taken to secure reliable results, the experiments here recorded were undertaken.

Falmouth, Jamaica, B.W.I.,
March 20th, 1888.

ON THE

SUPPOSED DISSOCIATION OF ZINC OXIDE, AND THE CONDITION OF THE ATMOSPHERE WITHIN A PLATINUM VESSEL HEATED BY A GAS FLAME.

By H. N. MORSE and W. M. BURTON.

Some years ago it was found by one of us that zinc, in the highest state of purity and in considerable quantity, can be prepared by subjecting the metal to fractional distillation in a vacuum. When the pressure is wholly removed the zinc distils at a temperature apparently not much above its fusing-point, while the other metals usually associated with it are at that temperature very much more or very much less volatile. The separation of zinc from lead by this method is especially rapid and satisfactory. It seemed desirable, therefore, that a re-determination of the atomic weight of the metal, with the elementary substance as a starting point, should be undertaken.

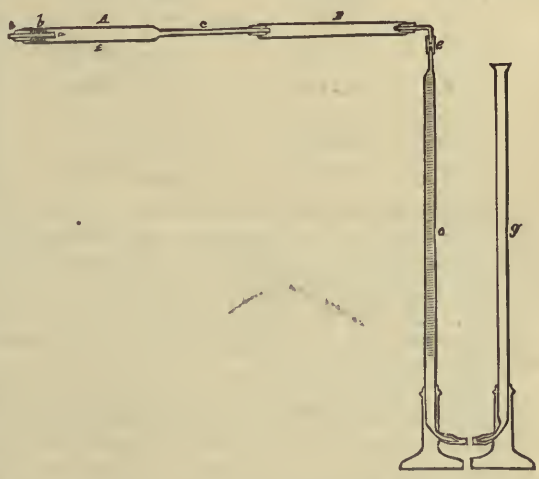
Of all the methods which have been employed for the purpose, or which suggested themselves as feasible, the determination by means of the oxide appeared to be the most simple and direct, and therefore the best, provided the stability of the oxide at high temperatures could be demonstrated. The details of our work will be published at a later date; but some of the results having a more general interest, we venture to present them now. Having demonstrated that the oxide of zinc does not lose weight when heated for many hours in the muffle furnace to a temperature above that required to fuse steel; moreover, that the platinum crucibles containing the oxide do not exhibit any trace of tarnish after such heating; we turned our attention to a phenomenon which must be familiar to many chemists, namely, that when the oxide of zinc is heated in platinum over a blast-lamp, or even over an efficient simple burner without blast, it constantly loses weight.

Axell Erdmann* observed, while making a determination of the atomic weight of zinc, that when the oxide is heated in a crucible the platinum becomes coated with a blue tarnish supposed to be an alloy of zinc and platinum. Much later Marignac† noticed the same tarnish upon the platinum when the oxide is heated over the blast-lamp; moreover, that there is a manifest distillation of the zinc out of the crucible and a constant loss in weight. This loss he ascribes to *dissociation* of the oxide.

In view of the results of Deville‡ relating to the dissociation temperature of water, and of Deville and Troost§ relating to the permeability at high temperatures of platinum to hydrogen, it appeared probable to us that the phenomenon is one of *reduction* and not of *dissociation*; that the temperature of the gas flame in parts being above that at which the dissociation of water begins, there is in the flame at the same time free oxygen and free hydrogen resulting from the dissociation of water previously formed by the combustion of the gas. The result would be an accumulation of free hydrogen on the inside of any platinum vessel heated in the gas flame, due to the more rapid diffusion of hydrogen through heated platinum. Our results have justified this explanation, and make it appear probable that the atmosphere within a platinum vessel heated by such flames as are employed in the laboratory is always a *reducing* atmosphere.

* *Ann. Chem.* (Liebig), l., 438.
† *Archives des Sciences Phys. et Nat.* (3), x., 193.
‡ *Jsb. Chem.*, 1860, 24.
§ *Ibid.*, 1863, 23.

The method of experimentation consisted in heating with a lamp the air contained in a platinum tube so arranged that the pressure could be varied at will; withdrawing it afterwards, and determining to what extent the oxygen had been converted into water. The figure exhibits the apparatus employed. A is a platinum tube; B, a glass tube of such capacity that A and B together hold about 130 c.c.; C, a Hempel burette. On the inlet tube, *a*, a number of discs, cut from asbestos board and ignited to destroy organic matter, are placed in order to protect the cork from the heat. The platinum tube is also cooled at the points *b* and *c* by wrapping with cloth which is kept wet by means of a dripping arrangement placed above. The tubes A and B are filled with air from the outside of the laboratary, closed at *d*, and connected at *e* with the gas burette, which was previously full of water. The flame is applied at *f*. When the air within has attained its maximum expansion, the level of the water in *g* is adjusted according to the pressure which it is desired to maintain in the apparatus. At the end of each ten minute period of heating the tube is allowed to cool down, in order to facilitate the mixing of the portions of the gas in A, B, and C. Finally a small glass tube, filled with water and dipping under water in a beaker, is attached at *d*; the gas withdrawn by lowering *g*, and analysed by the method of Hempel. The substances looked for, and determined when found, were carbon dioxide, oxygen, carbon monoxide, hydrogen, and nitrogen.



The quantity of carbon dioxide found was not in any case in excess of the quantity normally contained in the air, and was, of course, hardly measurable in the ordinary Hempel burette. Carbon monoxide was not found at all. The hydrogen was determined by absorption in palladium sponge, the tube containing it having first been filled with pure nitrogen. The fact that the air did not perceptibly diminish in volume when treated with caustic potassa to withdraw carbon dioxide, proves that no oxides of nitrogen were formed during the heating. Great care was taken in all cases, to use only an oxidising flame, and not to allow the internal cone containing the unburned gases to come in contact with the platinum tube. The results obtained are stated in Table I. The percentages of oxygen given represent the proportion of that element which *disappeared* during the heating, and are calculated on the basis that the air contains 20·9 per cent of oxygen and 79·1 per cent of nitrogen. The quantities of free hydrogen found are given in cubic centimetres.

In Table II. are given the number of c.c. of oxygen burned out in each experiment, also the minimum volume of free hydrogen which must have diffused from the flame into the tube. The calculation is, of course, based on

TABLE I.

No. of Exp.	Source of Heat.	Time of Heating.	Pressure.	Per cent of total Oxygen lost.	C.c. free Hydrogen found.
1.	Blast lamp.	1 Hour.	Atmos. press. less 30 m.m. Merc.	63·07	
2.	,,	1 ,,	,, ,,	62·08	
3.	,,	1 ,,	Atmos. press.	53·70	
4.	,,	1 ,,	,,	54·13	
5.	,,	1 ,,	Atmos. press.+30 m.m. Merc.	48·67	
6.	,,	2 ,,	Atmos. press.	88·49	
7.	,,	2 ,,	,,	88·53	
8.	,,	3 ,,	,,	98·14	2·4
9.	,,	4 ,,	,,	100·00	2·7
10.	Simple Bunsen burner without blast.	3 ,,	,,	55·56	
11.		6 ,,	,,	81·81	
12.		10 ,,	,,	97·00	0·7

the supposition that the residual nitrogen is to the oxygen originally mingled with it as 79·1 is to 20·9.

TABLE II.

No. of Exp.	Vol. of O_2 lost.	Min. vol of H_2.
1.	13·75 c.c.	27·50 c.c.
2.	14·89	29·78
3.	11·40	22·80
4.	11·41	22·82
5.	10·43	20·86
6.	21·73	43·46
7.	22·28	44·56
8.	21·03	2·4, 42·06 } 44·46
9.	22·75	2·70, 45·50 } 48·20
10.	12·50	25·00
11.	19·80	39·60
12.	22·81	0·70, 45·62 } 46·32

If we compare the results of experiments Nos. 1 and 2 with 3 and 4, and with 5, it appears that the diffusion of hydrogen from the flame through platinum is affected by difference in pressure, being greater when the pressure on the inside is diminished. It appears from experiments Nos. 8 and 12 that when the oxygen has been reduced to a small quantity, both free oxygen and free hydrogen may exist together in the tube.

Experiment No. 9 was undertaken in order to determine whether it is possible wholly to remove the oxygen, and the fact that the volume did not perceptibly decrease when the gas was passed into the phosphorus absorption pipette indicates that it may. But the gas, when it was returned to the burette for measurement, appeared to contain a minute quantity of the white clouds which appear when oxygen is absorbed by phosphorus. To settle this question satisfactorily, finer measuring apparatus and greater precautions against possible diffusion of oxygen from the outside will be required.

That the quantity of free hydrogen found in Experiment No. 9 was not markedly larger than that found in No. 8 is not surprising, because, the tube being hot on all sides, it passes out of the rear wall with nearly the same facility that it enters in front. Moreover, the connections are necessarily such that free hydrogen would be lost through them. It was our first plan to fill the tube with some gas free from oxygen, and to measure the hydrogen which accumulated in it; but the reflection that free hydrogen was not likely under the circumstances to accumulate with rapidity, and that the quantity found afterwards would be no measure of that which had diffused in during the experiment, led us to select air instead.

Our results appear to explain sufficiently the cause of the constant loss in weight when the oxide of zinc is heated in platinum over a gas flame, and to make it extremely probable that the atmosphere within any platinum vessel heated by any gas flame whatever, will receive free hydrogen. They also explain the origin of many of those tarnishes and sublimates which the analytical chemist so often finds on the inside of his crucible after heating substances supposed to be non-volatile. Since only the so-called oxidising portions of the flames were allowed to come in contact with the platinum, the free hydrogen which diffused through the metal must have been produced by the dissociation of water. Whether this dissociation is due solely to the high temperature of the flame, or in part to the influence of the platinum itself, is a question for further investigation. It appears not improbable that the very different rates of diffusion of hydrogen and oxygen through platinum at high temperatures may be a cause of the dissociation of the highly heated water vapour, just as different rates of diffusion through liquids of the constituents of some compounds may determine their decomposition while undergoing solution.

The idea suggests itself in this connection that the oxidising effect of the outer blowpipe flame may be due to the oxygen derived from dissociating water, rather than from the excess of oxygen blown into it. Such a supposition accords well with the common experience that the best oxidising effects are produced by the *hottest* flame, and not by the flame into which a large excess of air is pumped. A molecule of water heated to a temperature at which it becomes unstable would doubtless be a more active oxidising agent than a molecule of free oxygen.—*American Chemical Journal*, vol., x. No. 2.

THE CHEMICAL STRUCTURE OF THE NATURAL SILICATES.*

By F. W. CLARKE.

In any attempt to discuss the chemical structure of the inorganic silicates we are met at the outset by difficulties which are partly real and in part imaginary. On the one hand we have to deal entirely with non-volatile solids, of which, because of their fixedness, we cannot certainly ascertain the true molecular weights. They are, furthermore, insoluble and, chemically speaking, non-plastic; that is, they yield but stubbornly to reagents, so that the changes of which they are structurally capable can rarely be studied in the laboratory. These difficulties are very real. On the other hand, most of the definite silicates are natural minerals, and as such are commonly supposed to have a bewildering complexity of constitution. This difficulty is only apparent, not real, and is due to several causes. First, few mineral species occur in a state of even approximate chemical purity; and secondly, many of them, being isomorphous, crystallise together to form seemingly homogeneous bodies to which rational formulæ can hardly be assigned. Impurities, indefinite crystalline mixtures, and defective analyses account for many apparent complications. Eliminate from any group of natural silicates these disturbing conditions, and we shall

* *American Chemical Journal*, Vol. x., No. 2.

find in every case a simplicity of composition far removed from the complexity which is popularly assumed. Even on theoretical grounds we should expect simplicity of structure. The mineral silicates are, as a rule, exceedingly stable compounds, while complex molecules are relatively unstable. They are formed in nature under conditions of high temperature, or are deposited from solutions in which many reactions are simultaneously possible; circumstances that are strongly adverse to any great complications of structure. Finally, they are quite limited in number, only a few hundred at most being known; whereas, if complexity was the rule among them, slight variations in origin would produce great variations in character and millions of different minerals would be generated. That few substitutions occur is presumptive evidence that only few are possible, and hence simplicity of constitution is to be inferred. In fact we find the same small range of mineral species occurring under the same associations in thousands of widely separated localities, a few typical forms containing a few of the commonest metals being almost universally distributed. The longer the evidence is considered, the more overwhelming the argument for simple silicate structures becomes.

Suppose now that for any given silicate the empirical composition has been ascertained, how can its chemical structure be determined? We cannot measure its vapour density and so deduce its molecular weight; but the problem is not, therefore, necessarily hopeless. Several lines of available evidence are open. In some cases the compound may be synthetically reproduced in the laboratory, a kind of mineralogical investigation in which rapid progress is now being made. Again, the constant association of the species with certain others sheds light upon its genesis, and still oftener its alterations in nature furnish important details. An alteration product, despised by the crystallographer, is really a record of chemical change, and such products may be of the highest scientific interest. In a few researches they have been produced artificially by reactions which were prolonged for months at a time, and so a mass of evidence is slowly accumulating, strictly analogous in kind to that which the organic chemist chiefly depends upon for ascertaining the structure of a hydrocarbon. All these lines of evidence are legitimate, and all converge towards truly scientific conclusions. We know that certain silicates originated together, and that each alters in certain definite ways; and from these facts we may draw perfectly fair inferences as to chemical structure, and deduce rational formulæ which shall give fuller expression to our knowledge. The evidence for such formulæ is less perfect than that at the command of the carbon chemist, but it is none the less substantial so far as it goes. It is, furthermore, cumulative.

About three years ago, while I was working tentatively at the problem now under discussion, I received for examination certain specimens of topaz which were deeply altered upon their surfaces. Upon investigation the alteration product proved to be a variety of muscovite, and a study of the empirical formulæ of the two minerals revealed an unexpected relation between them. Further study brought out more extended relations connecting them with several other silicates, and by a natural series of steps I was led to adopt as a working hypothesis the supposition that double salts might be regared as substitution derivatives of normal salts. This hypothesis, since then steadily applied to the discussion of the silicates, appears to be supported by a weighty mass of evidence, and it leads to the development of a series of structural formulæ which satisfy many conditions. They express and interpret known relations, lead to the detection of others, and point out suggestive and profitable lines of research. By these tests any hypothesis must stand or fall, and one which, meeting them successfully, has at the same time philosophical significance, may be fairly looked upon as valid.

That the great majority of the natural silicates are double salts need hardly be stated, and that a very great number of them contain aluminum is also a commonplace of chemistry. Of the latter some are orthosilicates, and some are meta-compounds; and the problem is to show how each series may be derived from its corresponding normal salt. As the orthosilicates are the most important, we may begin with their consideration. They represent the maximum of complication and offer the greatest difficulties.

Fortunately, the orthosilicate of aluminum, $Al_4(SiO_4)_3$, occurs in nature as the mineral xenolite. This species, which is now well established, was long thought to be an impure variety of fibrolite, Al_2SiO_5; and in their optical properties the two are apparently identical. Fibrolite bears the closest of relations to its isomer, andalusite; and to the latter, topaz, $Al_2SiO_4F_2$, is crystallographically akin. Topaz, as I have already stated, alters into muscovite, $Al_3KH_2(SiO_4)_3$; and so also does eucryptite, $AlLiSiO_4$. To these compounds we may add paragonite, which is merely a sodium mica, and we have at least six silicates, including the normal salt, which are all evidently related to each other. That their empirical formulæ show little or no connection is due to the fact that they do not represent true molecular weights, and on this point our fundamental hypothesis gives us a key to the problem. If we triple the formulæ given for fibrolite, topaz, and eucryptite, the substitution theory which I have suggested at once becomes applicable, and the derivation of all the others from xenolite is easy. The following structures will make this conception clear:—

$$\begin{array}{l} \diagup SiO_4 \equiv Al \\ Al-SiO_4 \equiv Al \\ \diagdown SiO_4 \equiv Al \end{array} \qquad \begin{array}{l} \diagup SiO_4 \equiv (AlO)_3 \\ Al-SiO_4 \equiv Al \\ \diagdown SiO_4 \equiv Al \end{array} \qquad \begin{array}{l} \diagup SiO_4 \equiv (AlF_2)_3 \\ Al-SiO_4 \equiv Al \\ \diagdown SiO_4 \equiv Al \end{array}$$

Xenolite. Fibrolite. Topaz.

$$\begin{array}{l} \diagup SiO_4 \equiv KH_2 \\ Al-SiO_4 \equiv Al \\ \diagdown SiO_4 \equiv Al \end{array} \qquad \begin{array}{l} \diagup SiO_4 \equiv NaH_2 \\ Al-SiO_4 \equiv Al \\ \diagdown SiO_4 \equiv Al \end{array} \qquad \begin{array}{l} \diagup SiO_4 \equiv Li_3 \\ Al-SiO_4 \equiv Al \\ \diagdown SiO_4 \equiv Al \end{array}$$

Muscovite. Paragonite. Eucryptite.

In the second of these formulæ the univalent group $-Al=O$ is assumed, and in the third we have the corresponding group $-Al=F_2$. I think no chemist will regard these assumptions as strained.

Now the foregoing symbols all represent a series of salts derived from the first one by various substitutions of a single aluminum atom. But further replacements are theoretically possible, and the following minerals seem to illustrate them:—

$$\begin{array}{l} \diagup SiO_4 \equiv (AlO)_3 \\ Al-SiO_4 \equiv (AlO)_3 \\ \diagdown SiO_4 \equiv Al \end{array} \qquad \begin{array}{l} \diagup SiO_4 \equiv \\ Al-SiO_4 \equiv \\ \diagdown SiO_4 \equiv Al \end{array}$$

Dumortierite. Grossularite.

$$\begin{array}{l} \diagup SiO_4 \equiv CaH \\ Al-SiO_4 \equiv CaH \\ \diagdown SiO_4 \equiv Al \end{array} \qquad \begin{array}{l} \diagup SiO_4 \equiv NaH_2 \\ Al-SiO_4 \equiv NaH_2 \\ \diagdown SiO_4 \equiv Al \end{array}$$

Prehnite. Natrolite.

Dumortierite, which has been little studied, appears to be related to fibrolite, and the formulæ exhibit a relation. Grossularite, the lime alumina garnet, is a common associate of muscovite, a fact which lends verisimilitude to the formula given above. The other two formulæ represent the known composition of prehnite and natrolite, but whether they indicate any deeper relations is not yet proven. They do, however, suggest lines of investigation, and so far fulfil a useful purpose. If they are true, prehnite should be derivable from garnet, and garnet and muscovite ought to be mutually derivable from each other. That garnets do alter into micas is already well known, although the exact character of the change is undetermined,

and the micas involved in the reaction appear to be more complex than muscovite.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

April 28th, 1888.

Professor Reinold, F.R.S., President, in the Chair.

Messrs. W. H. Snell and A. W. Slater were elected Members of the Society.

The following communications were read:—

"*On Electromotive Force by Contact.*" By Mr. C. V. Burton, B.Sc.

The object of the paper is to discuss the seats of the electromotive forces developed by the contact of conductors. By considering the distribution of electricity on the surfaces of the conductors, and from the fact that the potential throughout their masses are constant except about a thin layer near the junction, the author deduces that *the molecular action which gives rise to a contact E.M.F. between two conductors is confined to the immediate neighbourhood of the junction.*

If E be the contact E.M.F., and M the quantity of electricity which passes across the junction when two metals originally at the same potential are placed in contact, it is shown that the work done is E M, half of which is spent in producing heat and half in raising the potential energy of the system. Since the conductors are supposed to be kept at constant temperature, and the action which gives rise to the E.M.F. is confined to the immediate neighbourhood of the junction, the molecular energy must be absorbed *at the junction.* By supposing the surface of contact very small and the capacity of the system large, it is shown that *heat* and *chemical action* are the only kinds of energy which fulfil the required conditions of supplying an indefinite amount of energy. Hence for substances chemically inactive *the true contact E.M.F. is equal to their coefficient of the Peltier effect expressed in absolute measure*; and for substances chemically active, but devoid of Peltier effect, *the E.M.F. is equal to the energy of combination of one electro-chemical equivalent.*

Since metal-metal contacts can only be the seats of Peltier E.M.F.'s, it is inferred that the *apparent contact E.M.F.* (measured inductively) must be due chiefly to air-metal contacts.

A list of analogous properties of Peltier and chemical E.M.F.'s is given in parallel columns. The results of some experiments on the contact E.M.F. of glass and ebonite with mercury are tabulated, but they are very irregular, and the author concludes that there is no true and definite contact E.M.F. between conductors and non-conductors.

Profs. Ayrton, Schuster, Thompson, and Perry discussed the points raised, and it was considered that direct experiment on contact E.M.F. in a very perfect vacuum could alone decide the questions.

"*On a Theory concerning the Sudden Loss of Magnetic Properties of Iron and Nickel.*" By Mr. H. Tomlinson, B.A.

Experiments by himself and other observers have shown that the temperatures at which iron and nickel lose their magnetic properties depend on the specimens used and the magnetising forces employed; but the temperatures at which they *begin to lose* these properties are definite,—for nickel about 300° C., and iron about 680° C. The author's own experiments on "Recalescence of Iron" show two critical temperatures; and Pinchon has shown by calorimetric measurement, that between 660° and 720° C., and between 1000° and 1050° C., heat becomes latent. All these facts seem to indicate a molecular rearrangement about these temperatures.

In his proposed theory he assumes that the molecules of iron (say) contain magnetic atoms capable of motions of translation and of rotation. These tend to form closed magnetic circuits, but at ordinary temperatures are unable to do so on account of the close proximity of their centres. On raising the temperature their centres are further separated, till at about 680° C. their polar extremities rush together, forming complete circuits and exhibiting no external magnetic properties. On cooling down, the centres approach until the gravitation attraction overcomes the magnetic attraction of their poles, when the magnetic properties reappear.

Prof. Ayrton asked whether the author had made experiments on the reappearance of magnetic properties when raised to a white heat, and Prof. Thompson enquired whether cobalt had been tested. Both questions were answered negatively.

"*Note on the Graphic Treatment of the Lamont-Frolich Formula for Induced Magnetism,*" By Prof. S. P. Thompson, D.Sc.

The formula referred to is—

$$N = \bar{N}\,\frac{Si}{Si + b},$$

where $\bar{N}$ = total induction when saturated, N = induction due to Si ampère turns, and b = value of Si, which makes $N = \frac{1}{2}\bar{N}$. Simple geometrical constructions are given for plotting the curve when $\bar{N}$ and b are known, and for finding $\bar{N}$ and b when two pairs of values of N and Si have been determined.

The use of the formula is shown to be justified in practice, for, as pointed out to the author by Prof. Perry, the curves connecting permeability, μ, and induction, B, are straight lines from B = 7000 to B = 16000, between which dynamos are usually worked. A method of predetermining $\bar{N}$ and b is given for magnetic circuits of known form and materials, thus removing the objection often urged against the above formula, viz., that it involves two constants which had to be determined after the magnet was made.

Two other "Notes," by the same author, were postponed till next meeting.

NOTICES OF BOOKS.

A Treatise on Electricity and Magnetism. By E. Mascart, Professor in the College de France, and J. Joubert, Professor in the College Rollin. Translated by E. Atkinson, Ph.D., F.C.S., late Professor of Experimental Science in the Staff College. Vol. II.—Methods of Measurement and Applications. London: T. De la Rue and Co.

The translator of this work, Dr. Atkinson, is of course favourably known to scientific and technical men in England, from his version of Ganot's "Physics," now generally recognised as a valuable text-book. The authors, MM. Mascart and Joubert, are also authorities of well-known merit and eminence.

The first three parts of the present volume are respectively devoted to methods of measurement, to electrical measurements, and to magnetic measurements.

The fourth part, under the peculiar title "Complement," treats of industrial applications and numerical constants. The applications here taken into consideration are chiefly those in which it is intended to utilise the electrical energy itself, as in galvano-plastics, lightning, or the transmission of mechanical power. The subject of galvano-plastics is very cursorily dealt with, and

electro-metallurgy, or the reduction of ores by the current, and the electric furnace are overlooked.

To readers well versed in the higher mathematics the work will be of great value, but to all others it must prove simply unintelligible. In the chemical formulæ introduced the old notation has been retained, copper sulphate, *e. g.*, being written CuO,SO_3+5HO.

There is a brief table of contents at the beginning of the volume, a very complete "index of subjects" at the conclusion, with references to pages, followed by an ordinary index for both volumes, in which the references are to paragraphs.

Organic Analysis: a Manual of the Descriptive and Analytical Chemistry of Certain Carbon Compounds in Common Use. For the Qualitative and Quantitative Analysis of Organic Materials; Commercial and Pharmaceutical Assays; the Estimation of Impurities under Authorised Standards; Forensic Examinations for Poisons and Elementary Organic Analysis. By A. B. Prescott, Ph.D., M.D. New York: Van Nostrand.

This book naturally suggests a comparison with a work very similar in its scope, by Mr. A. H. Allen. Dr. Prescott has, however, the advantage that his work is entirely in the hands of the public, whilst Mr. Allen is still in arrears. We likewise prefer Dr. Prescott's alphabetical arrangement to the classification adopted by Mr. Allen, which does not as readily permit the reader to find instructions for the examination of any substance required.

Dr. Prescott, however, seems to devote relatively too much space to poisons and medicinal products, and too little to the organic substances used in the arts and manufactures. We find here schemes for recognising or identifying colouring-matters on the fibre, or in substance, but we find no instructions, *e.g.*, for the examination and valuation of commercial samples of annatto, archil paste and liquor, carmine, cochineal, the dye-woods and their extracts, lac-dye, lake colours, indigo and its extracts, &c. In like manner there are here instructions for detecting and estimating gum, resin, starch in plant-analysis. But the student will not here learn how to distinguish the various starches and gums from each other. Soaps do not appear to enter into the author's plan; neither do varnishes, alizarin oils (as distinguished from the time-honoured *huile tournante*), and, indeed, not a few other commercial substances. The use of the microscope in the recognition of animal and vegetable bodies is referred to merely under the alkaloids, and we find no mention of the use of the spectroscope in the identification of colouring-matters. Hence, whilst in certain departments this work is decidedly valuable, we cannot pronounce it complete.

A Treatise on Alcohol, with Tables of Spirit Gravities. By Thomas Stevenson, M.D. (Lond.), F.R.C.P. (Lond.), F.I.C., &c. Second Edition. London: Gurney and Jackson.

This little book is not a mere reprint of the earlier edition, as the whole has been re-written in consequence of the recent researches on absolute or "dry" alcohol conducted by Messrs. Squibb. It is, however, admitted that the law according to which alcohol and water contract, when mixed together, has not yet been ascertained. In the meantime all persons interested, from whatever point of view, are compelled to depend upon actual experiment for the determination of spirit gravities.

Messrs. Squibb appear to have been the first chemists who ever obtained a really absolute alcohol, a task requiring great nicety and care, especially as such alcohol greedily absorbs water from the atmosphere. Their product had, at 60° F., the specific gravity of 0·79350. At the same temperature Mendeleeff had found 0·79404, Dupré and Page, 0·79391, and Fownes 0·7938. The author considers the tables of Fownes less trustworthy than those of Blagden and Gilpin.

In his tables the author gives, in parallel columns, the specific gravity of a spirit at 60° F. Water at the same temperature being taken = 1, the percentages of actual alcohol respectively by weight and by volume, and the percentage of proof-spirit. The reason why this "survival" is still taken as the official standard is the trouble and expense of rejecting the instruments and tables at present in use.

The value of Dr. Stevenson's work to analysts requires no exposition.

Outlines of Qualitative Analysis. By G. W. Slatter, A.R.C.Sc., F.I.C., F.C.S. London: Thomas Murby.

This work, extending only to 140 pages, is of necessity brief. It is not, we are glad to find, put forward as being specially arranged for students "preparing" for some examination. At the outset we meet with some "useful hints" on analytical work which are really useful and appropriate. Next follows a list of the apparatus required in colleges and schools, for each pupil; a catalogue of the general and special reagents needed; after which the author proceeds to "preliminary operations."

In the body of the work we do not meet with anything calling for special remark. Diagrams of the apparatus required are not given,—a very judicious limitation, as their value is not proportionate to their cost and the space which they take up.

In the Preface the author admits that the directions given for manipulation are very brief, rightly remarking, however, that more good will be effected by showing a student how a thing is done than by giving him copious written directions. The student who is obliged to dispense with practical instruction will find chemical manipulation not free from difficulties, and will require a large fund of patience.

CORRESPONDENCE.

ON SOLUTION.

To the Editor of the Chemical News.

Sir,—Will you allow me to call attention to an article on "Solution," by Prof. Pickering, in the Chemical News (vol. lvi., p. 181), and which I overlooked until the other day. In that article Mr. Pickering favours me with criticism and advice. For the latter I am much obliged, but do not feel much the wiser, as I was not unaware of the various cautions he refers to. When anyone criticises equations he should pay attention to the signs used, as these are sometimes important. He gives my first equation as—

$$Mg,Cl_2-Mg,O,Aq-(Ca,Cl_2-Ca,O,Aq)= \\ =MgCl_2,Aq-CaCl_2,Aq.$$

Now my equation correctly stated is—

$$Ca,Cl_2-Ca,O,Aq-(Mg,Cl_2-Mg,O,Aq)= \\ =MgCl_2,Aq-CaCl_2,Aq.$$

This is very different, as it brings out the *inverse* nature of the problem, and if his other equations were correct, would bring out the conclusion that—

$$CaCl_2,Aq-MgCl_2,Aq=MgCl_2,Aq-CaCl_2,Aq,$$

or, in other words, that it does not matter whether you put the horse before the cart or the cart before the horse. I find, however, that he puts—

$$Mg,Cl_2=2(H,Cl,Aq)+R+N+MgCl_2,Aq.$$

This is not correct.

$$Mg,Cl_2=2(H,Cl,Aq)+R+N-MgCl_2,Aq.$$

The other instances given are of a precisely similar nature and need no further comment. Stated in this, the correct way, Mr. Pickering's results, instead of proving

my views to be wrong, go far to confirm and strengthen them, as they bring out the intimate and inverse relation between ordinary chemical affinity and solution, and further putting aside my equation altogether then—

$$\left\{\begin{matrix}Mg,Cl_2 - \\ Mg,O,Aq\end{matrix}\right\} = (2(H,Cl,Aq) + R + N - MgCl_2,Aq) - \\ - (R + H_2O) = C.$$

It is evident the value of C depends positively on the excess of $2(H,Cl,Aq)+N$ over H_2O, and negatively on the value of $(MgCl_2,Aq)$, so that if there were no solution the excess of the heats of formation of all dry chlorides over those of their oxides in water would be a constant quantity of about 38,000 units. Now when the heat of solution approaches the sum or goes beyond it we have decomposition, the chlorine going to the hydrogen of the water, and the metal to the oxygen, clearly showing what the action is. The atoms are, as it were, turned round as the balance is in favour of the latter arrangement. The heat of solution indicates their approach to this state. Mr. Pickering is acquainted with what happens when $MgCl_2$, Al_2Cl_6, or PCl_3 are put into water, and I have shown in a paper published in the *Proceedings of R. S. Ed.*, July 15, 1887, that this is a regular recurring phenomenon, that, in fact, solution passes into decomposition, and is a periodic function of the atomic weights of the elements like other chemical phenomena.

I have no cause to quarrel with Mr. Pickering's idea that hydrates are formed in solution; they may be, although I think not, but if they are formed this does not account for solution, for it may be asked what forms the hydrates? I maintain solution is due to the chemical affinity of the constituent atoms for one another, and that affinity is not all exhausted in ordinary combinations. I am glad to know that my views coincide in many respects with Mr. Pickering's own. This, I suppose, refers to residual affinity, which he claimed to have suggested simultaneously with Dr. Armstrong in 1885; but as I stated this view in 1878, and was rather laughed at in consequence, I may claim that they, as well as Helmholtz, who made the same suggestion some years later, have followed me, and perhaps, if Mr. Pickering lives long enough (which I trust he may) he may find that seven years hence his views, as well as the views of a good many others, coincide with mine so far, at any rate, as solution is concerned.—I am, &c.,

William Durham.

Portobello, April 19, 1888.

NEW ELEMENTS.

To the Editor of the Chemical News.

Sir,—I have just observed the letter of A. E., dated the 19th of April, and published in the Chemical News of April 27th.

I am quite convinced in my own mind as to the peculiarities of the bodies alluded to, both in regard to their equivalents and to their reactions, and as to their difference from the elements hitherto described. I have, however, scarcely as yet taken any further steps to bring them under public notice, because other engagements have for long prevented me from devoting time to chemistry.

I shall be very much pleased if A.E. will address to me any questions on the subject, or communicate with me in any way he chooses, with a view to satisfying himself as to whether or not he has been working with the same elements as I have. Perhaps he and I may be able to assist one another.

With this object I enclose my address.—I am, &c.,

Alex. Pringle.

Yair, Selkirk, May 1, 1888.

Royal Institution.—Prof. W. Chandler Roberts-Austen, F.R.S., will lecture on Friday evening, the 11th of May, in place of Mr W. H. Barlow, F.R.S. The lecture will be "On Some Curious Properties of Metals and Alloys."

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of emperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 15, April 9, 1888.

The Fixation of Nitrogen by Certain Soils and Vegetable Moulds.—M. Berthelot.—In this paper the author criticises the experiments of M. Schlœsing, recently submitted to the Academy. He urges that even if the soil selected by M. Schlœsing was one of those which have the property of fixing atmospheric nitrogen, his experiments have involved a number of conditions which have been proved to be unfavourable to such fixation, such as the compactness of the soil, the presence of an excess of water, and the heating of the soil producing a current of steam in the mass. Each of these conditions, taken singly, would have sufficed to arrest the phenomenon, probably by destroying the vitality of the microbia which fix nitrogen.

Action of Carbon Tetrachloride upon Mineral Oxygen Compounds free from Hydrogen.—H. Quantin.—All oxygen compounds not containing hydrogen are attacked at varying temperatures by carbon tetrachloride; the non-metal and the metal which they contain pass into the state of oxychlorides whenever such compounds can exist in the conditions of the experiment in presence of an excess of carbon tetrachloride. The latter body itself is resolved into oxychloride and carbon dioxide. If the temperature is such that the oxychlorides formed are reduced, we obtain chlorides. The same results may be obtained by the action of a mixture of chlorine and carbon monoxide instead of the tetrachloride. These experiments show that carbon in gaseous combinations retains the reducing power which it has in the solid state.

On Rhodium Sesquichloride.—E. Ludié.—The author finds the action of chlorine upon heated rhodium is tedious and incomplete. He did not succeed in obtaining a chloride of constant composition. On heating rhodium sulphide in a current of chlorine the chlorine was not taken up as the sulphur was expelled. On heating the double rhodium alkali chlorides with excess of sulphuric acid and washing out the alkaline sulphate, there was formed, not, as Claus asserts, an insoluble rhodium sesquichloride, but a sparingly soluble sulphate mixed with alkaline sulphate. The author obtained the anhydrous sesquichloride by heating ammonium chloro-rhodate in a current of very dry nitrogen. The best process of preparing anhydrous rhodium sesquichloride is heating the alloy of rhodium and tin described by Debray in chlorine. The author has formed and examined certain double chlorides formed by hydrated rhodium sesquichloride with the alkaline chlorides.

The Passive State of Iron and Nickel.—E. Saint Edme.—The nickel of commerce immediately becomes passive if immersed in ordinary nitric acid. Iron, whilst being briskly attacked by common nitric acid, is rendered passive by contact with nickel. If steel and nickel are plunged into the acid together the former metal is not even momentarily attacked. Nickel retains energetically a proportion of combined nitrogen, to which its passivity is due.

Action of Zinc Cyanide upon Certain Chlorides.—M. Raoul Varet.—The author finds that zinc cyanide does not form molecular combinations with the chlorides.

Syntheses by Means of Cyanacetic Ether. Higher Homologues of Acetyl-cyanacetic Ether.—Alb. Haller.—This memoir does not admit of useful abstraction.

The Hydrocarbons accompanying Diterebenthyl in the Resin Oils.—Adolphe Renard.—The resin oils,

which represent almost 9-10ths of the products of the distillation of colophony, consist of a mixture of about 80 per cent of diterebenthyl, 10 per cent of diterebenthylene, and 10 of didecene.

Formation-Heat of Aniline.—P. Petit.—The author has examined this question by two methods, the results obtained being respectively −12·4 cals. and −13·0 cals.

The Volatility of the Polyoxygenated Carbon Compounds.—Louis Henry.—The simultaneous presence of several atoms of oxygen in the same region of a carbonised molecule has upon it a volatilising influence.

Combustion-heat of the Coal of the North of France.— M. Scheurer-Kestner.— Calculation does not lead to results which even approach the truth. The formula of Cornut departs least from reality, and that of Dulong most widely.

Researches on the Fixation of Nitrogen by the Soil and by Plants.—Arm. Gautier and R. Drouin.—The authors conclude from their experiments that monocellular algæ, and doubtless other aërobic beings, play a part in this fixation, as do doubtless the aërial parts of plants, and that whatever may be the initial state of this nitrogen, it passes into the organic state as well in the soil as in the plant.

Researches on Phosphorescent Hexagonal Blende.—A. Verneuil.—Not adapted for useful abstraction.

No. 16, April 16, 1888.

The Spectra of Oxygen.—J. Jansen. — The author has observed a fact which furnishes a remarkable demonstration of the law of the production of the dark bands which he has detected in the spectrum of oxygen. The phenomena of elective absorption in oxygen gas are manifested in two mutually distinct spectral systems. A first system, formed of fine rays, follows the law of the product of the gaseous system traversed by its density. The second system is formed of bands much less easily resolved, is governed by the law of the product of the thickness by the square of the density. This second law being quite novel in spectral analysis, the author has instituted experiments necessary to prove that this system of obscure bands really belongs to oxygen. These experiments range from pressures of 100 atmospheres down to those of a few units, and with lengths of tubes from 0·42 metre to 60 metres. At the same time prolonged observations have been made upon the atmosphere, brought into connection with the experiments in the tubes. These observations, and especially those made during autumn last on the Pic du Midi, prove that all the bands of the spectrum of oxygen are found in the spectrum of the solar light if it is allowed to traverse a sufficient thickness of the atmospheric medium. Further, on comparing, by the aid of photography, the intensities of the bands of the atmospheric spectrum with those given in the tubes, the author has found that the intensities of these atmospheric bands fulfil the law of the square. It appears from *Wiedemann's Annalen* that M. Olszewski, when liquefying oxygen, examined its spectrum and ascertained the existence of the bands in question with a stratum of 7 m.m. of liquid oxygen.

Relations of Atmospheric Nitrogen to Vegetable Soil. Reply to the Observations of M. Berthelot, inserted in the "Comptes Rendus" of April 9th.—Th. Schlœsing.—The writer maintains that Boussingault did not consider the vegetable soil as an inert and lifeless mass. M. Berthelot's critique on M. Schlœsing's own experiments is without foundation. Lastly, the writer does not deny the possibility of the fixation of atmospheric nitrogen in vegetable soil, but merely says that it is not proved by his experiments, nor by those of M. Berthelot.

Contribution to the Study of Cast-Irons. — F. Osmond.—The author's results show that the cast-irons of commerce are highly complex mixtures of different compounds or alloys.

On a Sodium-potassium Carbonate. — MM. Hugounenq and Morel. — Sodium and potassium carbonates can crystallise together, yielding isomorphous mixtures which cannot be represented by formulæ, as they may vary indefinitely.

Combustion-heat of the Coal of the North of France.—M. Scheurer-Kestner.—The author's results are given in a tabular form.

Thermo-chemistry of the Diazo-compounds.—Leo Vignon.—Like most thermo-chemical memoirs this paper does not admit of useful abstraction.

Volatility in Poly-oxygenated Carbon Compounds.—Louis Henry.—The volatilising influence is at its maximum when the two atoms of oxygen, the presence of which is its origin, are in the closest proximity. The influence is still powerful, though less energetic, when the two atoms of oxygen are fixed upon atoms of carbon distinct but adjacent. It is more feebly exerted when the atoms of oxygen are fixed upon atoms of carbon not immediately united. All volatilising influence ceases when the two atoms of oxygen are fixed upon atoms of carbon separated by the interposition of other atoms of carbon.

On Cyanaldehyd.—P. Chautard.—This compound, isomeric with acetyl cyanide, is a colourless limpid liquid, highly refringent, miscible with water without decomposition, soluble in all proportions in alcohol, ether, chloroform, and acetone. It is very volatile and inflammable, boils at 71·5°, and does not solidify at −20°. Its specific gravity is 0·881.

Action of Acids and Anhydrides upon the Terpilenols.—J. Lafont.—The terpilenols may be transformed into ethers, either by acetic anhydride or by formic and acetic acids. In this latter case the etherification is slow.

Synthesis by Means of Cyanacetic Ethers. III. Benzol, Ortho-toluol and Para-toluol-acetic Ethers.—Alb. Haller.—Not adapted for useful abstraction.

Researches on the Fixation of Nitrogen by the Soil and Plants.—MM. Gautier and Drouin.—A. Nitrogen of soils not planted. Here there was a disappearance of ammoniacal nitrogen, part of which had passed into the state of organic nitrogen. B. Nitrogen of planted soils. Here also there ensues a constant decrease of ammoniacal nitrogen and an increase of organic nitrogen.

The Biological Function of the Cholesteric Ethers named Lanoline.—Oscar Liebreich.—The author shows that lanoline is not peculiar to the wool of sheep, but exists in hair, scales, whalebone, the horns of ruminants, the spikes of the porcupine, the hoofs of horses, &c. It plays the same part on the surface of animals as does wax on the surface of plants. It is not readily saponified by caustic alkalies, and resists the attacks of microbia.

Moniteur Scientifique, Quesneville.
Series 4, Vol. ii., February, 1888.

The Causes of the Deterioration of Leaden Water Pipes.—Max Müller.—From the *Journal fur Praktische Chemie.*

Study on the Emulsive Oils and on a New Method of Examining Fatty Bodies.—R. Benedikt and F. Ulzer.—The method in question will be inserted at some length.

The Manufacture of Alpha-naphthylamine.— Dr. O. N. Witt.—This extensive memoir does not admit of useful abstraction.

The Formation of the Hyponitrites. — Messrs. Wyndham R. Dunstan and T. S. Dymond. — From the *Journal of the Chemical Society.*

Researches on the Ferric Hydrates.—Dr. Donato Tomasi.—The ferric hydrates may be divided into two isomeric series, the red, α, and the yellow, β. The former hydrates are obtained whenever a ferric salt is precipitated

by potassa, soda, or ammonia, or by the corresponding carbonates. Their reddish brown colour is universally known. The weakest acids dissolve them readily, and they are also soluble in ferric chloride, with which they form oxychlorides. They are easily dehydrated on boiling in water. On ignition they yield a black oxide. If dried at 35° to 40° they yield a dihydrate, and a monohydrate if dried at 90°. They occur in two modifications, soluble and insoluble, which are unstable and return to their original type, either on standing or under the influence of heat. The hydrates of the series β are obtained by the oxidation of the ferrous hydrate or carbonate or of the magnetic hydrate. On ignition they yield an oxide which varies in tone from a bright red to the yellow of burnt sienna. They are more stable than series α, never becoming anhydrous on prolonged boiling in water. If boiled in a strong solution of calcium chloride they still retain 1 mol. of water. They may be converted into the α-series by solution in hydrochloric acid and re-precipitation with ammonia. They do not combine with ferric chloride to form oxychlorides.

Researches on the Azimuths of Polarisation of Convergent Light on Emerging from Uniaxial Birefringent Laminæ.—Dr. G. Quesneville.—A mathematical paper, not susceptible of useful abstraction.

Contribution to the Knowledge of the Quinquina Alkaloids.—O. Hesse.—From *Liebig's Annalen.*

Chemical Composition of Howlite and Notes on Gooch's Method for the Determination of Boric Acid.—S. Penfield and E. Spierry.—From the *American Journal of Science.*

Action of Sea-Water upon Cast-Iron. — Carter Napier Draper.—From the Chemical News.

MEETINGS FOR THE WEEK.

Monday, 7th.—Medical, 8.30. (Annual Oration).
— Society of Arts, 8. "Decoration," by G. Aitchison, A.R.A.
— Royal Institution, 5. General Monthly Meeting.
Tuesday, 8th.—Royal Medical and Chirurgical, 8.30.
— Institution of Civil Engineers, 8.
— Photographic, 8.
— Society of Arts, 8. "The Decorative Use of Colour," by J. D. Crace.
— Royal Institution, 3. "The Plant in the War of Nature," by Walter Gardiner, M.A.
Wednesday, 9th.—Geological, 8.
— Microscopical, 8.
— Society of Arts, 8. "Locks and Safes," by Samuel Chatwood.
Thursday, 10th.—Mathematical, 8.
— Telegraph Engineers, 8.
— Royal Institution, 3. "The Chemical Arts," by Professor Dewar, M.A., F.R.S.
— Society of Arts, 2. Conference on Canals and Inland Navigation.
Friday, 11th.—Quekett Club, 8.
— Astronomical, 8.
— Society of Arts, 2. Conference on Canals and Inland Navigation.
— Royal Institution, 9. "Some Curious Properties of Metals and Alloys," by Chandler Roberts-Austen, F.R.S.
Saturday, 12th.—Royal Institution, 3. "The Later Works of Richard Wagner," by Carl Armbruster.
— Society of Arts, 11. Conference on Canals and Inland Navigation."
— Physical, 3. "Note of the Condition of Self-excitement in a Dynamo Machine," and "Note on the Conditions of Self-regulation in a Constant Potential Dynamo Machine," by Prof. S. P. Thompson. "Note on the Electrical Action of Light," by Mrs. W. E. Ayrton. "On the Theory and Practice of Applying the Dynamometer to the Investigation of Transformers," by T. H. Blakesley. "On Measuring the Electromotion Force of Dynamos and Motors," by Prof. W. E. Ayrton, F.R.S., and Prof. J. Perry, F.R.S.

Erratum.—In the paper on "The Compounds of Ammonia with Selenium Dioxide," at p. 163, *for* "selenosomic acid," *read* "selenosamic acid,"

A Young Chemist (Ph.D.), who has studied Five Years on the Continent, and made Technical and other Analysis his speciality, desires employment in a London Laboratory. Highest references.—Address, F. S. E., Chemical News Office, Boy Court, Ludgate Hill, London, E.C.

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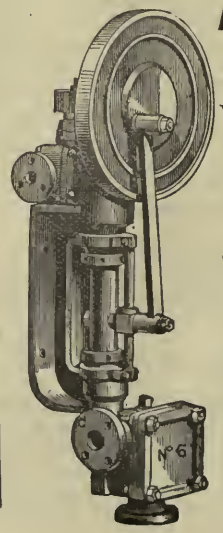

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THE CHEMICAL NEWS.

Vol. LVII. No. 1485.

IODIDE OF STARCH.

By H. B. STOCKS.

As all the experiments I had hitherto tried on iodide of starch (Chemical News, vol. lvi., p. 212) were done in the presence of water, or the liquid containing other products besides iodide of starch, which had been used in its formation, such as excess of iodine, or starch, &c., it seemed advisable to try the action of heat on dry iodide of starch, and for this purpose I prepared pure iodide of starch by adding iodine solution to starch paste in water; on adding alcohol, all the iodide of starch was thrown out of solution, it was filtered off, and dried carefully. The substance thus prepared was a black shining mass.

Some of this iodide of starch was heated for six or seven days at 100° C. without any odour of iodine being perceptible, and without its colour being destroyed. This was rather remarkable, because if heated in contact with water it would have very soon lost all its colour.

Another portion of this dry iodide was heated in a tube to a higher temperature than the above; it did not give off any iodine, nor change colour, until tarry matters began to come off; iodine vapour was then noticed in the tube along with the products of destructive distillation.

Iodide of starch is therefore a stable body, not acted upon by heat alone, up to at least 100° C., but in contact with water it is decomposed with formation of hydriodic acid in closed vessels, in open vessels with volatilisation of part of the iodine, the remainder being converted into hydriodic acid.

Iodide of starch, when dry, is not acted upon by sunlight.

On treating dry iodide of starch with water it did not dissolve, and required long boiling before it was decomposed; after decomposition, starch and a trace of hydriodic acid were found in the liquid.

Following up the experiments on the action of silver nitrate on iodide of starch, I divided the product into two portions, *i.e.*, precipitate and filtrate, and tried the action of each of these on a mixture of potassium iodide and starch paste, and found that the precipitate had no action, but that the filtrate immediately produced a blue colour; it is therefore evident that the substance which liberates iodine is in the filtrate.

The substance liberated is either nitrous or nitric acid, but as I could only find nitrous acid I conclude the equation is—

$$2AgNO_3+2I+H_2O=AgI+AgIO_3+2HNO_2.$$

This equation represents only the action of silver nitrate on the iodine, the starch undergoing no change.

I next tried the action of silver sulphate in place of silver nitrate, to see if it was nitrous acid that produced the blue colour, but was surprised to find that the blue appeared as with silver nitrate.

Looking up these reactions, I could only find mention of them by Fresenius, who says that when silver nitrate acts upon iodide of starch, silver iodide and hypoiodite (iodate) of silver are formed and gives—

$$I_6+6AgO,NO_5=AgO,IO_5+5AgI.$$

This would really require $3H_2O$, and HNO_3 would be formed thus—

$$I_6+6AgNO_3+3H_2O=AgIO_3+5AgI+6HNO_3.$$

As a preliminary experiment silver nitrate was precipitated by excess of iodine, and the precipitate washed from any soluble matter; this precipitate, added to a mixture of starch paste and potassium iodide, gave no blue, but on addition of dilute sulphuric acid, gave an immediate blue colour.

Dilute sulphuric acid, added to a mixture of starch paste and potassium iodide, did not become blue until it had stood some time, and this, of course, was due to decomposition of potassium iodide by the sulphuric acid.

Silver sulphate was precipitated by iodine and the precipitate washed from soluble matter; this precipitate, added to starch paste, produced no blue; with dilute sulphuric acid still no blue; potassium iodide added to this produced an immediate blue colour.

Silver iodate was next tried; when mixed with starch paste and potassium iodide and dilute sulphuric acid added, an immediate blue colour was formed.

The experiments above quoted serve to show the action of silver sulphate on iodide of starch, the action, of course, being on the iodine. The first change is the formation of silver iodate and silver iodide, represented by the following equation—

$$3Ag_2SO_4+6I+3H_2O=5AgI+AgIO_3+3H_2SO_4,$$

but there is some action between the sulphuric acid liberated and silver iodate, and, as a result, iodic acid passes into solution, and this acting upon potassium iodide liberates iodine, which combines with the starch forming the blue colour, the reaction being—

$$HIO_3+5HI=6I+3H_2O.$$

A soluble iodide or hydriodic acid is necessary to this reaction, as silver iodide is not acted upon under these circumstances.

It will be seen from my former paper what bearing these experiments have on the conjectures of Mylius, that hydriodic acid is necessary to the formation of iodide of starch, as on looking at these experiments we should see that they prove just the contrary to what he affirms, and also prove that it is free iodine and not hydriodic acid and iodine together that produce the blue colour, besides giving us an insight into the action of free iodine on silver salts.

With regard to the blue colour of iodide of starch, Pohl states that with the different starches the colour is not the same, but I found it to be the same in all cases when the same quantities of iodine and of starch were used in each case. A small quantity of iodine gave an indigo blue with more iodine violet, and when the iodine was in excess it appeared green, but the iodide of starch which was precipitated by the excess of iodine was quite blue.

The blue colour of iodide of starch is destroyed by potassium permanganate, with, after some time, deposition of oxide of manganese. In this case the starch is destroyed.

Iron filings destroy the blue colour, but zinc and sulphuric acid did not destroy it.

When bromine water is added to a solution of iodide of starch the blue is destroyed; large excess of starch does not re-form the blue colour, but on carefully neutralising with sodium carbonate all the bromine may be neutralised; the iodine is thus liberated and the blue colour again formed. It is evident that the reason why bromine destroys the combination is the formation of bromide of iodine as before stated.

Potassium bichromate precipitates the blue compound, but does not destroy it.*

Iodide of starch heated with alcohol is rapidly decolourised, even at a moderate temperature, with formation of ethyl iodide. On boiling the solution the latter is volatilised.

Since writing my last paper M. Hönig and S. Schubert have published a paper on lichenin (*Monatsh.*, viii., pp. 452 to 465; and *Journal Chem. Soc.*, cccii., p. 127), in which they prove that lichenin is not coloured blue by iodine, but that the blue is due to a starch existing in the moss, which they have named lichen starch.

* *Erratum in Former Paper.*—Potassium bichromate, when added to a solution of potassium iodide and starch, did not produce a blue colour, but on addition of dilute sulphuric acid the blue was formed.

The blue colour that iodine gives with starches is therefore very characteristic, as it is not formed, as I am aware of, with any other body.

THE ELECTRO-CRYSTALLISATION OF METALLIC COPPER.

By H. N. WARREN, Research Analyst.

The apparatus made use of for the above-mentioned substance consists entirely of an open tube, closed at one extremity by means of a bladder diaphragm, and suspended in a solution of dilute sodium chloride. Into the tube is introduced a saturated solution of cupric sulphate, the strength of the solution being maintained by the insertion of a smaller tube terminating in a point, and containing crystals of $CuSO_4$. A strip of copper-foil, about 3 inches long by 1 inch wide, is next introduced into the copper solution, and connected by means of a copper-wire to a plate of zinc, forming the negative electrode and in contact with the salt solution. After the lapse of a few hours small cubical crystals of metallic copper gradually begin to appear on the copper electrode, which in the course of a week or more will have arranged themselves into a compact crystalline mass, possessing a full metallic lustre, and rivalling in purity and malleability the finest specimens of native copper, which they much resemble. Metallic silver, antimony, bismuth, zinc, and even aluminium, magnesium, iron, chromium, and all the more oxidisable metals, may by slight alterations be reduced to the metallic state.

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EFFECT OF CHLORINE ON THE ELECTROMOTIVE FORCE OF A VOLTAIC COUPLE.*

By Dr. G. GORE, F.R.S.

If the electromotive force of a small voltaic couple of unamalgamated magnesium and platinum in distilled water is balanced through the coil of a moderately sensitive galvanometer of about 100 ohms resistance, by means of that of a small Daniell's plus that of a sufficient number of couples of iron and German silver of a suitable thermo-electric pile (see *Proc. Birmingham Philos. Soc.*, vol. iv., p. 130), the degree of potential being noted, and sufficiently minute quantities of very dilute chlorine water are then added in succession to the distilled water, the degree of electromotive force of the couple is not affected until a certain definite proportion of chlorine has been added; the potential then suddenly commences to increase, and continues to do so with each further addition within a certain limit. Instead of making the experiment by adding chlorine water, it may be made by gradually diluting a very weak aqueous solution of chlorine.

The minimum proportion of chlorine necessary to cause this sudden change of electromotive force is extremely small; in my experiments it has been 1 part in 17,000 million parts of water,† or less than 1-7000th part of that required to yield a barely perceptible opacity in ten times the bulk of a solution of sal-ammoniac by means of nitrate of silver. The quantity of liquid required for acting upon the couple is small, and it would be easy to detect the effect of the above proportion, or of less than 1-10,000 millionth part of a grain of chlorine in one tenth of a cubic centimetre of distilled water by this process. The same kind of action occurs with other electrolytes, but requires larger proportions of dissolved substance.

As the degree of sensitiveness of the method appears extreme, I add the following remarks:—

The original solution of washed chlorine in distilled water was prepared in a dark place by the usual method from hydrochloric acid and manganic oxide, and was kept in an opaque well-stoppered bottle in the dark. The strength of this liquid was found by means of volumetric analysis with a standard solution of argentic nitrate in the usual manner, the accuracy of the silver solution being proved by means of a known weight of pure chloride of sodium. The chlorine liquid contained 2·3 m.grms., or 0·03565 grain of chlorine per c.c., and was just about three-fourths saturated.

One-tenth of a c.c. of this solution (No. 1) or 0·003565 grain of chlorine was added to 9·9 c.c. of distilled water and mixed. 1 c.c. of this second liquid (No. 2) or 0·0003565 grain of chlorine, was added to 99 c.c. of water and mixed; the resulting liquid (No. 3) contained 0·000003565 grain of chlorine per c.c. To make the solutions (No. 4) for exciting the voltaic couple, successive portions of 1-10th or 1-20th c.c. of No. 3 liquid were added to 900 c.c. of distilled water and mixed.

I have employed the foregoing method for examining the states and degrees of combination of dissolved substances in electrolytes, and am also investigating its various relations.

* A Paper read before the Royal Society, May 3rd, 1888.

† As 1 part of chlorine in 17,612 million parts of water had no visible effect, and 1 part in 17,800 millions had a distinct effect, the influence of the difference, or of 1 part in 500,000 millions, has been detected.

RESEARCHES ON ALLOISOMERISM.*

I.

By ARTHUR MICHAEL.

There is scarcely a subject in organic chemistry that has attracted more attention and has been more fully investigated than the isomerism of maleic and fumaric, and citra-, ita-, and mesaconic acids. The interest shown in the examination of these acids has been largely due to the difficulty that the present theories of structural chemistry find in giving a satisfactory explanation of their constitution. Kekulé,† whose brilliant investigation of these acids may be considered as forming the corner-stone of our knowledge of their structure, made an attempt at an explanation, but it can hardly be considered as throwing much light on the subject. It was next considered by H. Kolbe, who in this, as in all other questions relating to isomerism and constitution of organic compounds, showed the keenest insight of any chemist of his time. Kolbe gave maleic and fumaric acids substantially the constitutions at present generally adopted.‡ Somewhat later, Kekulé§ returned to the subject, and assigned analogous constitutions to the methyl homologues:—

$CH_2—COOH$	$CH_2—COOH$	$CH_2—COOH$
|	|	|
C	CH_2	CH
|	|	|
$CH_2—COOH$.	$=C—COOH$.	$CH—COOH$.
Itaconic acid.	Citraconic acid.	Mesaconic acid.

The formulæ of the first two acids were changed by Meilly,‖ in accordance with a better knowledge of the constitution of pyrotartaric acid, to the following:—

* *American Chemical Journal*, Vol ix., No. 3.

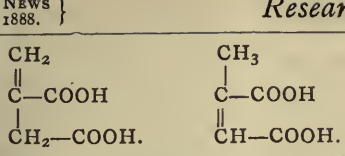
† *Annalen der Chemie*, Suppl., ii., 114.

‡ *Lehrbuch*, 1ste Aufl., ii., 579. Changed in accordance with the present notation, they are represented by—

$$\begin{array}{l} CH_2—COOH \\ | \\ C \quad —COOH \end{array} \quad \text{and} \quad \begin{array}{l} CH—COOH \\ \| \\ CH—COOH. \end{array}$$

§ *Zeitschrift fur Chemie*, N. F., iii., 652.

‖ *Annalen der Chemie*, clxxi., 153.



To explain the isomerism of mesaconic acid, Henry* and Markownikoff† supposed it to be a polymeride of citraconic acid; a view, as Fittig has remarked, that can hardly be upheld, as Hübner and Schreiber‡ had shown that the evidently analogously constituted fumaric and maleic acids have the same molecular weight. Van't Hoff § deserves the credit of considering the subject from a new point of view. In his pamphlet on the constitution of organic substances he concluded that the isomerism of maleic and fumaric, and of citraconic and mesaconic, acids cannot be represented by the present views on the molecular constitution of organic compounds, and attempted to show that it may be explained by his ingenious hypothesis concerning the configuration of the molecule in space. This chemist suggested that several other knotty problems of organic chemistry may be explained in the same manner; as the constitution of the two β-chlorcrotonic and bromcinnamic acids, as well as those of angelic and tiglinic acids. It is perhaps because Van't Hoff made no experimental contribution to the question, and the adopted structural theories permitted what seemed to most chemists a more plausible explanation of these cases of isomerism than that proposed by him, that his views were not adopted. The question was then made by Fittig‖ and his pupils the subject of an elaborate series of investigations. Fittig revived the formulæ of fumaric and maleic acids suggested by Kolbe, and believed that his work confirmed them. He followed a suggestion previously made by Kekulé, which is, that compounds containing a bivalent carbon should form addition products with more readiness than those containing so-called doubly-linked carbons. He showed that Kekulé's previous observation of the greater facility with which maleic and citraconic acids go over into saturated compounds than their isomerides is true in other reactions. These views seem to have been adopted by the majority of chemists, although it was known that a great many organic compounds containing so-called double bonds form addition products with equal facility; indeed Anschütz¶ has shown that fumaric ether takes up bromine with as great readiness as any maleic compound; and they are evidently based on that curious dogma of double bonds of the existence of which there is not a tittle of satisfactory proof. Finally, as to the latest contributions on the subject, I refer to Kekulé and Anschütz's** hypothesis that fumaric acid consists of a right- and left-handed optically active maleic acid; to Le Bel's†† geometrical formulæ; to Erlenmeyer's‡‡ chemical explanation; and to a brief discussion of these and other views on the subject by the writer.§§

It seemed as if contributions to our knowledge of this intricate case of isomerism might be made in two directions. In the first place, a more exact and general method of distinguishing between acids belonging to the fumaric and maleic series was desirable. The present means of distinction, which rests on the capability of the acid of forming an anhydride, means that the operation must be performed at a temperature where intramolecular changes are not unlikely to occur, that a comparatively large amount of the acid must be used, and it is not applicable to a large number of unsaturated acids, the classification of which would doubtless throw light on the constitution of the already classified acids; secondly, an examination of such unsaturated halogen acids as the so-called δ-chlor- and β-isochlorcrotonic, and α- and β-bromcinnamic acids, with a view of bringing indisputable proofs in regard to their constitutions. The present views on the constitution of organic compounds seem to many chemists to represent a state of finality, instead of being only a guide to a better insight; and this is probably the reason why the constitution of so many compounds is accepted without any further proof, simply because their existence is indicated by the present hypotheses. In no part of organic chemistry is this more noticeable than among unsaturated acids and their halogen derivatives, where the constitution of many compounds has been assigned in apparent contradiction to all analogy, simply that their existence may be explained by the present views on chemical isomerism.

A clue to a general method of distinguishing between acids of the fumaric and maleic series was found in an observation made by Gottlieb,* that an aqueous solution of the aniline salt of citraconic acid gives citraconanil on boiling, while a solution of the isomeric aniline mesaconate can be evaporated to dryness without undergoing a change. On following this line of investigation it was found than the distinction is general between acids of the fumaric and maleic series, and the results obtained form the subject of the following communications.

I. A Relation between the Constitution of Polybasic Unsaturated Organic Acids, and the Formation of their Anilides.

By Arthur Michael.

Behaviour of Maleic Acid towards Aniline.

To a solution of 8 grms. of maleic anhydride (1 mol.) in 100 grms. of water, 7·4 grms. of aniline (1 mol.) were added. The aniline went immediately into solution, which was then heated in a water-bath, when presently needles began to separate. After heating for an hour the contents of the flask were allowed to cool, filtered, and the filtrate heated again, when it gave a further deposit of needles on cooling. The substance was purified by several crystallisations from alcohol, and gave on analysis the following result:—

0·2314 grm. substance gave 0·6115 grm. CO_2 and 0·1145 grm. H_2O.

	Theory for $\begin{matrix} CH—CONHC_6H_5 \\ \vert \\ CH—CONHC_6H_5 \end{matrix}$.	Found.
C	72·18	72·07
H	5·26	5·49

The anilide crystallises from alcohol in long white needles that melt at 211° to 212°. It is somewhat soluble in hot, sparingly in cold, water; readily in hot, pretty soluble in cold, alcohol. It is insoluble in dilute mineral acids and alkalies. The formation of the anilide may be represented as follows:—

$$\begin{matrix} CH—COONH_3C_6H_5 \\ \vert \\ CH—COONH_3C_6H_5 \end{matrix} = \begin{matrix} CH—CONHC_6H_5 \\ \vert \\ CH—CONHC_6H_5 \end{matrix} + 2H_2O.$$

Besides the dianilide of maleic acid, a second substance, which remains in the alcoholic mother-liquor, is formed in the reaction. This compound is insoluble in dilute acids and alkalies, and may represent the anil.† ‡

* *Bull. Soc. Chim.*, xxiii., 347.
† *Annalen der Chemie*, clxxxii., 353.
‡ *Zeitschrift fur Chemie*, N. F., vii., 712.
§ "La Chimie dans l'Espace."
‖ *Annalen der Chemie*, clxxxviii., 95; cxcv., 128, 169; cc., 87.
¶ *Berichte der Deutschen Chemischen Gesellschaft*, xiii., 1541.
** *Berichte*, xiv., 717; xviii., 1400.
†† *Bull. Soc. Chim.*, xxxvii., 300.
‡‡ *Berichte der Deutschen Chemischen Gesellschaft*, xix., 1937.
§§ *Ibid.*, xix., 1381; xx., 554.

* *Annalen der Chemie*, lxxvii., 277.
† I have lately noticed that W. H. Perkin observed the formation of anilides from aqueous aniline maleate about six years ago (*Berichte*. xiv., 2540), and also that aniline fumarate remains unchanged. He made no analyses, and did not follow up the experiments.
‡ This paper, including the note referring to Perkin's observations, was in the hands of the printer when I received a paper by Anschütz and Wirtz (*Annalen der Chemie*, ccxxxix., 137) on the anilides of fumaric and maleic acids. These chemists have made a detailed

Behaviour of Fumaric Acid towards Aniline.

A dilute aqueous solution containing fumaric acid and aniline, in proportion to form the acid aniline salt, was heated for several days in a flask connected with an upright cooler. No precipitate was formed under these conditions, neither did anything separate from the solution on cooling. It contained unchanged aniline fumarate, and gave a precipitate of fumaric acid on addition of chlorhydric acid. This experiment was repeated with the same result with a concentrated solution of the salt, as well as when aniline in proportion to form the neutral aniline salt was used. If an aqueous solution of acid aniline fumarate is concentrated in an evaporating dish, it will be noticed that towards the end of the operation a precipitate is deposited. This consists of fumaric acid, as both the acid and neutral aniline salts of fumaric acid, when boiled with water, gradually decompose into acid and free base, the latter passing off with the steam.

Behaviour of Monobrommaleic Acid towards Aniline.

Monobrommaleic acid (obtained from dibromsuccinic acid by boiling with water, and melting at 128°) was dissolved in about 7 parts of water, and an equivalent quantity of aniline added. The base dissolved, and presently a crystalline precipitate separated. This consisted of clusters of plates, melting at 128° to 128½°, soluble in dilute chlorhydric acid. They are the acid aniline salt.

0·2592 grm. salt gave 0·1665 grm. AgBr.

	Theory for $\begin{array}{l}CBr—COONH_3C_6H_5{}^{*}\\ \quad|\\ \quad CH—COOH.\end{array}$	Found.
Br	27·75	27·30

If this acid salt is dissolved in water, and the solution allowed to stand several days at ordinary temperature, it will be noticed that a crystalline substance gradually separates.

0·2472 grm. gave 0·1708 grm. AgBr.

	Theory for $\begin{array}{l}CBr—CONHC_6H_5\\ \quad|\\ \quad CH—COOH.\end{array}$	Found.
Br	29 63	29·36

The compound is the acid anilide of brommaleic acid, and crystallises in prisms. It is insoluble in dilute chlorhydric acid.

The action of aniline on brommaleic acid in the heat gives entirely different results from those obtained by allowing the reaction to proceed in the cold. The solution, on boiling, soon turns yellow, and a crystalline substance begins to separate. This substance is best made by heating a solution of the neutral aniline salt in about 30 parts of water, in a flask connected with an upright condenser, to boiling for about twenty minutes, and filtering the liquid while hot. The yellow precipitate was purified by several crystallisations from alcohol, and was found to be free of bromine.

0·2055 grm. substance, dried at 100°, gave 0·5513 grm. CO_2 and 0·0839 grm. H_2O.

	Theory for $C_{16}H_{12}N_2O_2$.	Found.
C	72·73	73·10
H	4·55	4·62

The substance crystallises from alcohol as ochre-coloured, round clusters of microscopic needles that melt at 229° to 230°. It is moderately soluble in hot, sparingly in cold, water; in hot alcohol it is pretty soluble, less in cold. The substance is insoluble in dilute acids and alkalies, but on standing with dilute solutions of the last reagent it very slowly goes into solution, to form the salt of a different substance, which is precipitated on addition of acids,—a result that takes place much more rapidly if warm alkali is used.

The aqueous filtrate from the yellow needles deposits a second substance, mixed with some of the first, on cooling. To separate these substances they may be crystallised from a small amount of water, filtering off the insoluble portion. It is easier, however, to treat the mixture with a very dilute solution of caustic alkali, which dissolves the new substance, leaving the yellow needles behind. The filtrate was carefully neutralised, and the precipitate purified by crystallisation from alcohol. It does not contain bromine.

0·2153 grm. substance, dried at 100°, gave 0·5389 grm. CO_2 and 0·102 grm. H_2O.

	Theory for $C_{16}H_{14}N_2O_3$.	Found.
C	68·09	68·23
H	4·96	5·27

The substance separates from water as very slightly yellow-coloured, round groups of indistinct small crystals that melt at 176°. It is quite soluble in hot, moderately in cold, water. Alkalies dissolve it immediately, and the addition of an acid causes a precipitate of the unchanged substance.

These substances stand in a simple relation to phenylamido-maleic acid, a substance that may be supposed to be the first product of the action of aniline on brommaleic acid in the heat:—

$$\begin{array}{l}CBr—COONH_3C_6H_5\\ |\\ CH—COONH_3C_6H_5\end{array} = \begin{array}{l}CNHC_6H_5—COOH\\ |\\ CH—COOH\end{array} + C_6H_5NH_3Br.$$

This acid unites with aniline to form a salt, and, being under conditions that make the existence of an aniline salt of a derivative of maleic acid impossible, a condensation takes place:—

investigation of the substance designated as the dianilide of maleic acid, and find that it gives phenylaspartic acid when treated with acids or alkalies. In view of these observations they change the constitution of the anilide to that of the isomeric anil of phenylaspartic acid. The constitution I assigned to the compound was the only one that could be given it at the time of the experiment. I take this opportunity to explain the mistakes that led Mr. Wing and myself (*Amer. Chem. Journ.*, vii., 282) to give the constitution of a fumaric dianilde to the anil of maleic acid. A nitrogen estimation (owing to an erratum 0·1484 grm. of substance was printed instead of 0·1984 grm.) gave 10·19 per cent, a result that agrees fairly well with the amount indicated by theory. A carbon and hydrogen analysis gave 69·24 C and 4·30 H. This analysis was rejected, as everything seemed to point to the impossibility of the substance being an anil. It gave fumaric acid on continued boiling with water, and as there was no ground for supposing the existence of an anil of fumaric acid, the only explanation would have been the conversion of a maleic derivative into fumaric acid by heating with water, which seems very improbable. In the second analysis Mr. Wing made the mistake of adding the increase of weight of the solid caustic potash twice, and thereby got results that agreed with those indicated by the dianilide. Anschütz and Wirtz seem to have overlooked our statement that the compound is decomposed by continued boiling with water into fumaric acid and aniline, and give the existence of the supposed dianilide of maleic acid as a reason for our believing the compound to be an anilide of fumaric acid; but, as the empirical constitution of the maleic derivative was unknown at the time, it is not likely that this could have entered into our calculations. Perkin's observation on the formation of the anil of phenylaspartic acid differs from mine, as he heated the dry product to 100°, while I have made a point of showing the anilide formation in the presence of water in my experiments. The fact that an anilide is not formed from aniline mesaconate had already been noticed by Gottlieb, and the formation of citraconanil from a cold solution of aniline citraconate would seem, judging from the observations mentioned in the following paper, to be a mistake. As already stated, Perkin made no analyses, nor did he follow up his observations, and his opinion in regard to the constitution of the maleic acid derivative was based solely on the fact that aniline citraconate under the same conditions gives citraconanil. In view of this it is not a little surprising that Anschütz and Wirtz should endeavour to convey the impression that the views of Perkin and myself on the constitution of the substance conflicted. It would seem as if advantage was taken of circumstances to convey to the reader what seems to me to be almost a misrepresentation of the actual state of affairs.

* In this, and in a number of other constitutions, it is assumed that the base will unite with the carboxyl of the acid that is most under the influence of negative radicals.

$$\begin{array}{l} CNHC_6H_5—COOH \\ | \qquad\qquad = \\ CH—COONH_3C_6H_5 \end{array}$$

$$= \begin{array}{l} CNHC_6H_5—COOH \\ | \\ CH—CONHC_6H_5 \end{array} \quad (C_{16}H_{14}N_2O_3)+H_2O\,;$$

$$\begin{array}{l} CNHC_6H_5—COOH \\ | \qquad\qquad = \\ CH—CONHC_6H_5 \end{array}$$

$$= \begin{array}{l} CNHC_6H_5—CO \\ | \qquad\qquad \diagdown NC_6H_5. \\ CH \quad — \quad CO \end{array} \quad (C_{16}H_{12}N_2O_2)+H_2O$$

The bright yellow substance, according to this interpretation, is the anil of phenyl-amido-maleic acid, and the pale yellow compound an acid anilide of the same acid.*

Behaviour of Bromfumaric Acid towards Aniline.

Monobromfumaric acid (melting-point 177° to 178°, made by heating dibromsuccinic acid and water to 150° in a sealed tube, and also by treating brommaleic with fuming bromhydric acid) and aniline in equivalent proportions unite immediately to form the acid aniline salt. This salt is quite insoluble in water, much more so than the corresponding brommaleic acid salt, and by adding aniline to a solution of 1 part of acid in 30 parts of water a copious precipitate soon separates. For analysis it was crystallised from water. It melts at 153° to 154°, and is soluble in dilute chlorhydric acid.

0·2697 grm. salt gave 0·1750 grm. AgBr.

	Theory for $\begin{array}{l} CBr—COONH_3C_6H_5. \\ \quad | \\ \quad CH—COOH. \end{array}$	Found.
Br	27·75	27·53

This salt shows a much greater stability than the corresponding brommaleic derivative. It may be allowed to stand with water for weeks without undergoing a change, and its solution in water does not give, on long standing, a precipitate of an anilide. If a solution of the salt is boiled for about ten minutes a yellow precipitate begins to form, which becomes quite copious on long boiling. The solution, after boiling about an hour, was filtered hot, and the yellow precipitate crystallised several times from alcohol. The substance melted at 229° to 230°, and agreed in its properties with the yellow substance obtained by heating a solution of aniline brommaleate. In order to explain its formation it is necessary to assume that phenyl-amido-fumaric acid at the temperature of boiling water changes into the alloisomeric phenyl-amido-maleic acid, which in the presence of aniline decomposes into the anil.

(To be continued).

* Shortly after a preliminary note on this work (*Berichte*, xix., 1376) was sent to the *German Chemical Gazette* for publication, I received Part 6 of the journal that contained a paper by Reissert and Tiemann (xix., 626). These chemists had examined the action of aniline on dibromsuccinic acid, and obtained two compounds that are identical with the products obtained from the halogen fumaric and maleic acids. Reissert and Tiemann considered it probable that the anil represented a dipyridylene, but adopted the view presented in my preliminary note after its publication (Reissert, *ibid.*, xix., 1644). I should like to call attention to the constitution of the condensation products of phenyl-amido-pyrotartaric acid, which Tiemann and Reissert have classified as quinoline derivatives. Although they (*Ibid.*, xix., 624) mention that the compounds have the composition of methyl-fumaranilic acid and methyl-fumaranil, they reject the interpretation that their compounds are really the ones named; but their pyranilpyroinic anhydride has the melting-point of citraconanil (98°), and all the properties of that compound. Its formation is very readily understood when we bear in mind that β-amido acids have a tendency to decompose into unsaturated acids and bases, as is shown in the decomposition of β-amido propionic acid into acrylic acid and ammonia. The formation of citraconanil from phenyl-amido-pyrotartaric acid may be represented by the following equations;—

$$\begin{array}{l} CH_2—C—NHC_6H_5—CH_2 \\ \quad | \qquad\qquad | \\ \quad COOH \qquad COOH \end{array} = \begin{array}{l} CH_2—C—CH \\ \quad | \qquad\quad | \\ \quad COOH\,COOH \end{array} + NH_2C_6H_5 =$$

$$= \begin{array}{l} CH_2—C—CH \\ \qquad\qquad | \quad | \\ \qquad\qquad CO\,CO \\ \qquad\qquad \quad V \\ \qquad\qquad NC_6H_5 \end{array} + 2H_2O.$$

If, as Tiemann and Reissert assert, the so-called pyranilpyroinic acid is formed from citraconanil by alkalies, then this acid is citraconanilic acid; although the melting-point of that acid is 175°, and these chemists give 165° for their product. Perhaps a more detailed investigation will disclose the identity of citraconanilic acid with the acid obtained from their so-called anhydride; and if the first condensation product should turn out not to be citraconanilic acid, it doubtless has the constitution—

$$\begin{array}{l} CH_2—C—NC_6H_5—CH_2 \\ \quad | \qquad\qquad\qquad | \\ \quad COOH \qquad\qquad CO. \end{array}$$

VOLUMETRIC ESTIMATION OF SULPHURIC AND PHOSPHORIC ACIDS.

By JOHN TSAWOO WHITE.

This note is supplementary to my former article (Chemical News, vol. lvii., p. 165) under the same title. I have made further experiments on the determination and separation, where necessary, of these acids in the form of salts of the alkalies.

Two solutions of potassium sulphate and sodium phosphate were prepared. The strength of these solutions was determined from the weights of the barium sulphate and magnesium pyrophosphate obtained. In a solution containing both sulphate and phosphate, the phosphoric acid may be precipitated as basic magnesium phosphate. Add magnesium chloride in excess, followed by excess of ammonia, evaporate, and ignite. The residue is rinsed into a 250 c.c. flask with water, and diluted to the mark: 50 c.c. of the filtrate are evaporated with some NH_4Cl, and the ignited residue dissolved and titrated; 100 c.c. is treated as for determination of sulphuric acid; and the results are calculated for the total volume. The difference of the two titrations gives the chlorine equivalent of sulphuric acid. The filtrate from the magnesium phosphate contains no phosphoric acid. Five c.c. of a saturated solution of $MgCl_2$ diluted to 250 c.c. will give a solution, 1 c.c. of which will be sufficient to precipitate 0·004 P_2O_5.

I had previously tried to separate the phosphoric acid as ferric phosphate by ferric chloride, the excess of iron being removed by ammonia. The filtrates contained both iron and phosphoric acid, and the results were invariably high.

In determining phosphoric acid in presence of sulphuric acid, even an excess of 50 c.c. silver solution (1 c.c. = 0·001 Cl) in 250 c.c., if it could be completely changed into silver sulphate, would not give a precipitate of Ag_2SO_4, being within the limits of solubility. Below are the results obtained in grammes:—

SO_3.	
Taken.	Found.
0·0393	0·0389
0·0393	0·0387
0·0393+0·040 P_2O_5	0·0387
P_2O_5.	
0·0200	0·0192
0·0200+0·0393 SO_3	0·0199

I believe that my results are new. I may, however, be tracing unconsciously the footsteps of a previous worker.

Rangoon, April 11, 1888.

Reproduction of Pharmakolite: a Chemical and Optical Study.—H. Duet.—The author obtains calcium arseniate in a crystalline state, identical in form with the crystals of natural pharmacolite. The composition of pure crystals is given as $2CaO,HO,AsO_5+4HO$, in opposition to the formula $2CaO,HO,AsO_5+5HO$, deduced from the analyses of Klaproth and Rammelsberg.—*Comptes Rendus*, Vol. cvi., No. 17.

THE CHEMICAL STRUCTURE OF THE NATURAL SILICATES.*

By F. W. CLARKE.

(Concluded from p. 178).

Returning now to fibrolite, we find that it is a mineral which is liable to alter through a process of hydration. Some of its alteration products have been described as species, notably under the names wörthite and westanite, the latter being apparently the final product. Certain other species of the same group frequently undergo a sort of degradation into clays, which, unfortunately, are often too impure to admit of precise formulation. Still, of the several clays which are certainly definite, two seem to fall into series with fibrolite and westanite, as the following structures show :—

$$\begin{array}{l} \diagup SiO_4 \equiv (AlO)_3 \\ Al — SiO_4 \equiv Al \\ \diagdown SiO_4 \equiv Al \end{array} \qquad \begin{array}{l} \diagup OH \\ Al — SiO_4 \equiv Al \\ \diagdown SiO_4 \equiv Al \end{array}$$

Fibrolite. Westanite.

$$\begin{array}{l} \diagup OH \\ Al — SiO_4 \equiv H_3 \\ \diagdown SiO_4 \equiv Al \end{array} \qquad \begin{array}{l} \diagup OH \\ Al — SiO_4 \equiv H_3 \\ \diagdown SiO_4 \equiv H_3 \end{array}$$

Kaolinite. Montmorillonite.

Now, suggestive as these formulæ are, they represent only a selection out of a much larger number, all of which seem to follow essentially the same structural rule. If the case rested here it would still be a strong one, but it becomes even stronger when we study some of the more complex orthosilicates, and some of the silicates containing other inorganic acids. In most of the foregoing instances we have one aluminum atom linked with three of the orthosilicic groups, and making a sort of fundamental nucleus to which the other atoms of each molecule are attached. But in many cases we seem to have a semi-polymerisation of that nucleus which results in the elimination of one of the silicas, leaving a new group of atoms which may be represented as follows :—

$$\begin{array}{l} \diagup SiO_4 \equiv \\ Al — SiO_4 \\ \diagdown SiO_4 = \\ \diagup \\ Al — SiO_4 = \\ \diagdown SiO_4 \end{array}$$

This group, saturated by various bases, seems to exist in many natural silicates, notably among the iron and magnesian micas; and from it certain mixed salts, like sodalite and nosean, may be represented as derived. Thus, to cite a few examples, we may write :—

$$\begin{array}{l} \diagup SiO_4 \equiv FeH \\ Al — SiO_4 \equiv FeH \\ \diagdown SiO_4 = K_2 \\ \diagup \\ Al — SiO_4 \equiv FeH \\ \diagdown SiO_4 \equiv FeH \end{array} \qquad \begin{array}{l} \diagup SiO_4 \equiv Na_3 \\ Al — SiO_4 \equiv Al \\ \diagdown SiO_4 = Na_2 \\ \diagup \\ Al — SiO_4 \equiv Al \\ \diagdown Cl \end{array}$$

Annite. Sodalite.

$$\begin{array}{l} \diagup SiO_4 \equiv Na_3 \\ Al — SiO_4 \equiv Al \\ \diagdown SiO_4 = Na_2 \\ \diagup \\ Al — SiO_4 \equiv Al \\ \diagdown SO_4 — Na \end{array} \qquad \begin{array}{l} \diagup SiO_4 \equiv Na_3 \\ Al — SiO_4 \equiv Al \\ \diagdown SiO_4 = Na_2 \\ \diagup \\ Al — SiO_4 \equiv Al \\ \diagdown S — Na. \end{array}$$

Nosean. Ultramarine.

The last of these four formulæ is purely hypothetical and rests upon the recognised mineralogical analogies between lapis lazuli and nosean. It is, however, a formula which should be capable of synthetic verification, for ultramarine, itself a product of synthesis, yields many derivatives, the formation of which can be systematically studied. Possibly the lines of research followed by Lemberg, in his work on the alterations of elacolite, may be fitly applied to the investigation of lapis lazuli. As for annite, I have discussed its relations, together with those of the lithia micas, in a previous paper,* in which I have also given some suggestions concerning the part played by fluorine in lepidolite, cryophyllite, and phlogopite. Sodalite and nosean were considered in a still earlier paper,† in connection with cancrinite, nephelite, and other species. It is hardly necessary to repeat either discussion here.

Passing now to the metasilicates, we find ourselves, as regards the aluminous salts, at some disadvantage. The normal compound, $Al_2(SiO_3)_3$, is not known to exist by itself in nature, although certain of its derivatives are common. Its formula, however, may be written in two ways, as follows, and to one of these types some of the double aluminous metasilicates should conform :—

$$\begin{array}{l} Al = SiO_3 \\ \diagup SiO_3 \\ Al \\ = SiO_3 \end{array} \qquad \begin{array}{l} \diagup SiO_3 \diagdown \\ Al — SiO_3 — Al. \\ \diagdown SiO_3 \diagup \end{array}$$

Which of the two is best sustained by evidence?

To answer this question we may appeal to several well-known minerals, such as spodumene, $AlLi(SiO_3)_2$, jadeite, $AlNa(SiO_3)_2$, leucite, $AlK(SiO_3)_2$, and pyrophyllite, $AlH(SiO_3)_2$. All of these can be generalised under one formula, thus :—

$$\begin{array}{l} Al = SiO_3 \\ \diagdown SiO_3 — R, \end{array}$$

which is directly derivable from normal salt No. 1, and is not derivable from No. 2. Furthermore, kyanite, an isomer of fibrolite, Al_2SiO_5, is regarded by Groth and others as a basic metasilicate, for reasons which need not be re-considered here. As such its formula is $Al_2(SiO_3)O_2$, which may be derived from either of the formulæ for the normal compound. But pyrophyllite often occurs as the gangue of kyanite, which suggests a genetic relation between the two, and so makes it highly probable that the latter mineral should be written—

$$\begin{array}{l} Al = SiO_3 \\ \diagup O \\ Al \\ = O \end{array}$$

rather than as a derivative of the second formula for $Al_2(SiO_3)_3$. Formula No. 1, then, is the more probable formula for aluminum metasilicate. Two isomers may be possible, but the evidence so far favours only one compound.

In addition to orthosilicic and metasilicic acids, at least two other silicic acids correspond to known salts. These are the compounds $H_2Si_2O_5$ and $H_4Si_3O_8$. Still more are possible, but it is not necessary to assume them in order to account for known minerals. Derived from $H_2Si_2O_5$ we have a few species, notably petalite, $AlLi(Si_2O_5)_2$, which is the equivalent of spodumene in structure. The other acid, $H_4Si_3O_8$, is represented only by the species albite and orthoclase, $AlNaSi_3O_8$ and $AlKSi_3O_8$ respectively. If we triple these formulæ we have structures quite analogous to the orthosilicates, in which the normal aluminum salt $Al_4(Si_3O_8)_3$ is the starting point for derivation. Now it is universally believed, in accordance with the views of Sterry Hunt and Tschermak, that the triclinic felspars consist of various mixtures between albite and anorthite as two extremes. If our fundamental hypothesis is true, each of these minerals is

* *American Chemical Journal*, Vol. x., No. 2.

* *Amer. Journ. Sci.*, Nov., 1886.

† *Amer. Journ. Sci.*, April, 1886.

derived by substitution from a normal salt, and the formulæ so deduced become strikingly suggestive :—

$$\begin{array}{l} \quad\;\; SiO_4 \equiv \\ Al-SiO_4 \equiv Al \\ \quad\;\; SiO_4 \equiv Al \end{array} \qquad \begin{array}{l} \quad\;\; Si_3O_8 \equiv \\ Al-Si_3O_8 \equiv Al \\ \quad\;\; Si_3O_8 \equiv Al \end{array}$$

Anorthite is the lime salt corresponding to the first formula, and albite is the soda salt corresponding to the second. Another comparison is even more striking. The four silicates, most frequently associated with each other in granite veins, are muscovite, garnet, albite or orthoclase, and tourmaline. Tourmaline, according to the analyses made by Mr. Riggs in the laboratory of the United States Geological Survey, is always represented by the general formula $R'_9BO_2(SiO_4)_2$, in which at least the equivalent of R'_3 is present as aluminum. This gives us the following quartette of formulæ :—

$$\begin{array}{l} \quad\;\; SiO_4 \equiv KH_2 \\ Al-SiO_4 \equiv Al \\ \quad\;\; SiO_4 \equiv Al \end{array} \qquad \begin{array}{l} \quad\;\; SiO_4 \equiv \\ Al-SiO_4 \equiv \\ \quad\;\; SiO_4 \equiv Al \end{array} \Big\} Ca_3$$

Muscovite. Garnet.

$$\begin{array}{l} \quad\;\; BO_2 \\ Al-SiO_4 \equiv R_3 \\ \quad\;\; SiO_4 \equiv R_3 \end{array} \qquad \begin{array}{l} \quad\;\; Si_3O_8 \equiv K_3 \\ Al-Si_3O_8 \equiv Al \\ \quad\;\; Si_3O_8 \equiv Al \end{array}$$

Tourmaline. Orthoclase.

The suggestiveness of these symbols can hardly be questioned. All four are covered by the one general hypothesis; and tourmaline, furthermore, is known to alter into muscovite.

Leaving the aluminous salts, the other silicates present few structural difficulties. Isomorphous mixtures become perhaps more common, but when they are resolved into their constituents relatively simple compounds are found. The commoner bivalent metals form both ortho- and meta-silicates, and to them the substitution hypothesis, as a rule, easily applies. Only in the meta-silicate series do we find notable difficulties, and they may be avoided by the assumption of polymeric molecules. Thus, instead of $R''SiO_3$, we should write $R''_2(SiO_3)_2$, in which one atom of R'' becomes replaceable. This conception is by no means new, and is indeed quite commonly in use; but I may be permitted to cite one item of evidence in its favour. When solutions of calcium chloride and sodium meta-silicate are mixed, a white precipitate of calcium metasilicate is thrown down. This reaction I have studied under various conditions of temperature and concentration, and I find that when the precipitated salt is carefully dried over sulphuric acid it has the composition $2CaSiO_3.5H_2O$. That is, the double molecule $Ca_2Si_2O_6$ is required in order to avoid a formula containing a half molecule of water. By itself this fact is not of weighty importance, but it counts for something in confirmation of the prevalent views.

Concerning mixed silicate molecules, partly ortho- and partly meta-compounds, I have nothing at present to say. Such silicates undoubtedly exist, as well as aluminous silicates derived from normal salts of magnesia or lime. Nor do I venture to assert that all known silicates are as yet interpretable by simple structural means. There are many outstanding cases which still seem very obscure, but which I confidently expect will be cleared up in time. The micas, chlorites, and scapolites especially need a great deal of farther study. Various theories have been proposed to account for the composition of these groups, but not one is absolutely conclusive and satisfactory. The new method of discussion which I have proposed is yet to be fully applied to these minerals, but a wider knowledge of their variations is essential to its complete application. Whether the method shall be finally established as valid remains to be seen, but its results so far, at least entitle it to respectful consideration. As a working hypothesis the substitution theory has value, even though it should be ultimately overthrown.

In conclusion, there is one question to be considered. With the silicates the supposition that double salts are substitution derivatives of normal salts appears to work exceedingly well. But how about double salts in general? With such compounds as the sulphates, chromates, tartrates, oxalates, &c., there seem to be few difficulties; but with the double haloids, acetates, formates, &c., the case is not so clear. Their explanation is troublesome, at least in accordance with current views concerning the valency of their acid radicles; but those views are not absolutely incapable of modification. There may be exceptions to the general hypothesis of derivation, but chemists are not likely to be satisfied with partial theories, and all double salts ought to come under one common law. Toward that ultimate purpose the present paper tends, even though the road which it opens may not reach the final goal.

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

Annual Meeting, May 1, 1888.

Sir Frederick Bramwell, D.C.L., F.R.S., Honorary Secretary and Vice-President, in the Chair.

The Annual Report of the Committee of Visitors for the year 1887, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The real and funded property now amounts to above £81,000, entirely derived from the contributions and donations of the members.

Forty-one new Members were elected in 1887.

Sixty-three lectures and nineteen evening discourses were delivered in 1887.

The Books and Pamphlets presented in 1887 amounted to about 283 volumes, making, with 463 volumes (including periodicals bound) purchased by the Managers, a total of 746 volumes added to the Library in the year.

Thanks were voted to the President, Treasurer, and the Honorary Secretary, to the Committees of Managers and Visitors, and to the Professors, for their valuable services to the Institution during the past year.

The following gentlemen were unanimously elected as officers for the ensuing year:—

President—The Duke of Northumberland, K.G., D.C.L., LL.D.

Treasurer—Henry Pollock.

Secretary—Sir Frederick Bramwell, D.C.L., F.R.S., Mem. Inst. C.E.

Managers—George Berkley, M. Inst. C.E.; Sir James Crichton Browne, M.D., LL.D., F.R.S.; Vicat Cole, R.A.; Frank Crisp, LL.B., B.A., F.L.S.; William Crookes, F.R.S.; Warren de la Rue, M.A., D.C.L., F.R.S.; Sir Henry Doulton; John Hall Gladstone, Ph.D., F.R.S.; Colonel James A. Grant, C.B., C.S.I., F.R.S.; The Rt. Hon. Sir William R. Grove, D.C.L., F.R.S.; Rev. John Macnaught, M.A.; Sir Frederick Pollock, Bart., M.A.; William Henry Preece, F.R.S., M. Inst. C.E.; John Rae, M.D., LL.D., F.R.S.; Sir Henry Thomson, F.R.C.S.

Visitors—Capt. W. de W. Abney, R.E., F.R.S.; William Anderson, M. Inst. C.E.; Benjamin Baker, M. Inst. C.E.; John Birkett, F.R.C.S.; Michael Carteighe, F.C.S,; James Farmer; John Piggin Fearfield; Ernest H. Goold, F.Z.S.; Charles Hawksley, M. Inst. C.E.; David Edward Hughes, F.R.S.; Thomas John Maclagan, M.D.; Lachlan Mackintosh Rate, M.A.; John Bell Sedgwick, J.P., F.R.G.S.; Basil Woodd Smith, F.R.A.S.; James Wimshurst.

NOTICES OF BOOKS.

Half-Yearly Report (from July to December, 1887) of the Medical Officer of Health, Port of London.

An interesting and important report upon the sanitary condition of the Port of London during the last six months has recently been presented to the Corporation by Dr. Collingridge, the Medical Officer for the Port of London. This shows that 10,587 vessels of all classes have been inspected in the district, and that of these no fewer than 9298, or 87·83 per cent, were under the British flag, a larger proportion than usual.

These vessels were mostly found to be in a thoroughly sanitary condition, and in 831 cases only was it found necessary to order cleansing of any part to be carried out.

The majority of these orders were carried out promptly and willingly, and in no case had legal proceedings to be taken.

Eleven vessels were fumigated on account of infectious disease having occurred on board, and in eight cases parcels of clothing were fumigated. In 135 vessels some structural alterations were carried out with a view to improve their sanitary condition. Dr. Collingridge says, "with regard to these structural alterations, I would again point out the great economy that would be exercised by ship-owners and builders if they would only consult experts during the construction or repairs of vessels, when the expense of improvement is always nominal, and often non-existent," and suggests that an inspection of sanitary arrangements without expense to the owner should be made compulsory.

Attention is again called to the unsatisfactory state of the river, and some complete scheme urged for dealing with the sewage of the metropolis.

A few isolated cases of small-pox occurred in the Port, and as these present interesting points a few brief particulars are given of each. In one case a telegram from the Medical Officer of Health for Plymouth stated two cases of small-pox were coming round to London in s.s. *Kaikoura*. The vessel arrived at Gravesend the following day, and three cases (one of which subsequently died) were removed to the Port Sanitary Hospital. She was fumigated on her way up the river to the docks. The vessel left Wellington on August 25, and arrived at Rio de Janeiro on Sept. 16, small-pox being then very prevalent in that port. Here they embarked nine seamen, one of whom sickened with the disease on October 1st, and two others on the 2nd. The six healthy seamen were landed at Plymouth and the small-pox patients sent on to London.

Notice was sent to the Medical Officer of the Local Government Board protesting against the practice of passing disease in from an outport to London. There is firstly the increased danger of the ship's complement by reason of the longer exposure to infection; secondly, the risk of introducing disease into London; and thirdly, the objectionable, though probably convenient, practice of saddling the Corporation of London with the expense of maintenance and treatment which should properly fall upon the Plymouth Port Sanitary Authority. Dr. Collingridge further states that no cholera has been existent on the Continent within what may be termed dangerous distance of our shores, though obviously there is a possibility of its being conveyed by ship from *any* infected port.

The order issued by the Local Government Board prohibiting the importation of rags from Italy expired on December 31, 1887. In only one case was any action under this order required. The morality of allowing rags to be sent to another port when officially convinced of the danger of admitting them to our own is, to say the least, very doubtful. The absurdity of the present arrangement, moreover, is apparent when one considers that in all probability the same rags were re-imported from some other port not coming within the terms of the order. How much simpler and how much more reasonable to insist upon the disinfection of all rags entering the country. If this was carried out by the Port Sanitary Authorities it could be done at a nominal rate, and one great source of danger would be removed. Cholera is a rare danger, but other diseases, notably small-pox, have repeatedly been remitted by means of infected rags.

A large number of mild cases of scarlet fever and mumps occurred on the *Worcester* Thames Training College, off Greenhithe. The source of infection was not definitely traced, though in all probalitity derived from London, where the disease was more prevalent than usual.

The report, in referring to infected clothing, points out that although the dangerous practice of sending home clothing of persons who have died from infections has greatly diminished, still cases occur from time to time.

In thirteen cases unsound meat has been destroyed on account of its condition. In all except one instance the quantity fortunately was small. The one exception involved the destruction of over 5000 quarters of beef.

The Hospital has received only eight cases during the half-year; of these, five were admitted for small-pox, two for chicken pox, and one for enteric fever.

Canal Boats.—During the last twelve months 721 have been inspected; speaking generally, these boats are found in good condition and well cared for. The enforcement of the Act has done much for the physical and moral improvement of their inhabitants. These 721 boats were registered for a population of 2867, and carried only 1940. No case of infectious disease has occurred on canal boats during the last twelve months. It has only been necessary to prosecute in seven cases; in six fines were inflicted.

Notes on Inorganic Evolution. By E. A. Ridsdale, Associate of the Royal School of Mines. London: H. K. Lewis.

In this small pamplet the author has taken what seems to us a great step in working out the question of inorganic evolution. He introduces a new and luminous principle, the "survival of the most inert." He points out that if the chemical changes which we recognise in the world are taking place in some one direction, they must afford a clue to the past career of our globe. No one will question but that, generally speaking, bodies held together by feeble affinit es tend to be broken up, while those held together by stronger affinities remain unchanged. But compounds may also persist if their elemental affinities are feeble, so that they have no disposition to enter into any new combination. Hence the body which survives is that which, as a whole, is most inert, that which is least likely to react with adjacent bodies. On the other hand, the least inert bodies must tend to disappear.

Whatever conditions may prevail in coming ages, the author thinks it likely "that bodies inert under such conditions will tend to accumulate, whilst the more active bodies will be combined and re-combined until they are effaced in an inert condition."

Few chemists probably, on due consideration, will hesitate to follow Mr. Ridsdale so far, especially if they weigh the evidence which he adduces. But if we admit the "survival of the most inert" we find ourselves face to face with a number of conclusions, strongly probable, if not absolutely certain. We are led to see that "bodies which may appear to be elements under one or even many environments, may be easily broken up when the conditions are unfavourably altered." The author submits that, though these considerations are "not a proof that there may not be one or more true elements capable of withstanding every possible environment, there is strong presumptive proof that many, if not all, of the so-called 'elements' are elemental only inasmuch as we have not yet been able to isolate a sufficiently powerful set of conditions." He continues:—"Every chemical body is

'elemental'—*i.e.*, undecomposable—to some set of conditions, or it could not exist, and an element *may* only be a body stable under more extreme conditions than usual." This theory naturally leads to the conclusion that in every group of elements those with the lowest atomic weights were formed first, and those with the highest last. Bodies with high atomic weights, being formed under conditions of "greater chemical lethargy," would tend each to be more inert than its predecessors of the same series, as we find so signally shown in the halogen group.

We do not propose following the author any further at present, but we would bespeak for his work the most careful scrutiny. His fundamental idea, the survival of the most inert, deserves to be kept well in view during chemical research and geological observation. Unless we are much mistaken it will prove highly fruitful.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of emperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 17, April 23, 1888.

The Fixation of Nitrogen by Vegetable Mould. Reply to the Observations of M. Schlœsing.—M. Berthelot.—The author maintains that microbia induce in the soil not merely decompositions, as formerly admitted, but also true syntheses.

Certain Spectral Rays of Gold.—Eug. Demarçay.—The author criticises an investigation by Prof. G. Krüss, who, on revising the rays of gold and comparing his own results with those obtained by M. Lecoq de Boisbaudran, found several of the rays of the latter author wanting, and ascribed this discrepancy to traces of platinum and palladium examined by M. de Boisbaudran. He takes up the four rays specified by Prof. Krüss as wanting, *i.e.*, 523·0, 443·7, 433·8, and 406·4, and maintains that the first-mentioned is due neither to platinum nor palladium, but is one of the strong rays of gold. The ray 443·7 coincides with a faint platinum ray, but it may be seen in the entire absence of that metal. The ray 433·8 does not fall near any ray of either platinum or palladium, and is pronounced due to the process employed by Prof. Krüss; 406·4 coincides with a faint ray of platinum, but is seen in the complete absence of that metal.

Combustion-heat of the Coal of Northern France.—M. Scheurer-Kestner.—The most effective coals which have come into the author's hands are those of Creuzot.

Researches on the Fixation of Nitrogen by the Soil and Plants.—Arm. Gautier and R. Drouin.—The authors conclude that the bare soil acquires, from the atmosphere, notable quantities of nitrogen if it contains organic matter, such as humus, the necessary medium of such fixation. The iron oxides accelerate the process, but are not absolutely necessary. Thénard observed, in 1859, that at 100° they become agents in nitrification, but no nitre has been generated in the author's experiments. Whatever may be its initial state, the nitrogen thus withdrawn from the atmosphere is converted into organic nitrogen. The soil is the seat of a constant loss of the ammoniacal nitrogen brought by the wind and the rain, or derived from bacterian fermentations. In the fixation of nitrogen by the soil its permeability, state of division, and heaping up, play a considerable part. Soils heaped up and rendered little permeable by means of a slight excess of kaolin, or by varnishing the part in which they are contained, absorbed in an equal time thirteen times less nitrogen than the same soils rendered physically permeable. The total quantity of nitrogen assimilated by bare soils in three months in presence of organic matter are, on an equal area and in the same time, ten times greater than the quantities of ammoniacal nitrogen fixed by acidulated water exposed to the air of the fields in the experiments of M. Schlœsing. The intervention of plants doubles the total quantity of nitrogen fixed.

Researches on Perseite.—M. Maquenne.—Perseite, discovered by Muntz and Marcano in the leaves and fruits of *Laurus persea*, is a hexatomic mannite, and consequently, as was surmised by its discoverers, a true isomer of the mannite of manna and of dulcite.

Moniteur Scientifique, Quesneville.
Series 4, Vol. ii., February, 1888.

Industrial Society of Mulhouse.—Meeting of December 14, 1887.

M. Scheurer read a note from M. Albert Frey on the use of De Haen's "antimony salt" in dyeing and printing. This salt is a combination of antimony terfluoride and ammonium sulphate readily soluble in water, containing 47 per cent antimony sesquioxide, and having a strongly acid reaction. Its solution attacks glass and metals, and should consequently be used only in wooden vats. If employed for fixing tannin it should be neutralised with half its weight of soda crystals. The quantity to be used per litre is 4 grms. of the antimony salt and 2 grms. soda crystals, taking the pieces through the solution at 50°; 4 grms. of the antimony salt take the place of 5 grms. of the double tartrate. The shades are brighter than those obtained with tartar-emetic, and the whites purer, which proves that the colouring-matter is better fixed.

M. Noelting read a note from M. St. de Kostanecki on the relations existing between the constitution of colouring-matters and their power of dyeing mordanted tissues.

M. Scheurer read a letter from M. Albert Schlumberger with specimens of the author's safety envelopes. They are tinted in such a manner as to turn black, blue, and red, if an attempt is made to open them by wetting or by exposure to steam, whilst moist air or fog does not affect them.

M. Noelting gave in, on behalf of Dr. G. Lunge, of Zurich, a memoir on the reactions which take place in the lead-chambers.

Effects upon the Ductility of Silver produced by Traces of Bismuth.—The author adds to the solution the smallest possible quantity of hydrochloric acid requisite for the complete precipitation of the silver and increases the quantity of nitric acid in which the metal was dissolved.

Claim of Priority against Prof. Lothar Meyer on the Subject of the Action of the Carbon Chlorides.—H. Quantin.—See *Comptes Rendus* for January 27th, 1887

March, 1888.

Studies on Diastase.—C. J. Lintner.—From the *Journal fur Praktische Chemie.*

Contributions to the Study of Levulose.—H. Winter.—The author concludes that the specific rotatory power of levulose in an aqueous solution at 20 per cent is $-71{\cdot}4°$ at a temperature of 20°. The method of preparation and the raw material employed have no influence upon the optical properties of the product. Levulose may be dried at 50° in a vacuum without change, and has then the composition $C_6H_{12}O_6$. Alcohol considerably reduces the rotatory power of levulose, but slightly augments that of dextrose. The specific rotatory power of pure anhydrous levulose in solution in absolute alcohol is $-47°$ for $P=7{\cdot}78$. A mixture of equal parts of levulose and dextrose does not possess the optical properties of inverted sugar. Levulose combines with calcium oxide, lead oxide, chloride, and nitrate, and bismuth nitrate. The author further advances, though with some reservation, that two parts of levulose and one

part of hydrated dextrose form a crystalline compound. Inverted sugar is composed of four parts of levulose and three parts of hydrated dextrose. Levulose forms an alcoholate of the formula $C_6H_{11}O_6(C_2H_5)$.

Lecture delivered before the Society of Arts in London on the Chemistry of Substances which Play a Part in Putrefaction and Antiseptics.—J. Thomson.

Destruction of Rabbits in Australia and in New Zealand.—M. Pasteur.—The subject matter of this memoir, which is biological rather than chemical, has been repeatedly before the public.

Influence of Sodium Nitrate upon Gun-cotton.—F. Nettlefold.—From the Chemical News.

On a Sulphur Island in New Zealand.—Emerson Macivor.—From the Chemical News.

Effects of Small Quantities of Bismuth on the Ductility of Silver (concluded).—As long as ingots contain less than 0·5 of bismuth per thousand their ductility is not materially decreased.

Further Contributions to the Metallurgy of Bismuth.—E. Matthey.—A paper communicated to the Royal Society.

The Alkali Industry in England.—A. Fletcher.—A paper read before the British Association at its last meeting.

Chemical Patents taken out at Berlin.—Preparation of acetic acid with simultaneous production of charcoal. Dr. R. Weids. W, No. 5022.

Preparation of hydrated alumina from alkaline earths. Dr. K. Bayer. B, No. 7849.

Preparation of chromium and its alloys. V. E. Rouff. R, No. 4347.

Production of ammonia from desaccharised treacle without previous calcination and simultaneous production of oxalic acid. Dr. E. Meyer. M, No. 5334.

Saponification of fatty bodies with ammonia for the production of soda-soaps. Carl Polony. P, No. 3374.

New salt of soda and method of its preparation. J. J. Watts and W. A. Richards. W, No. 4892.

Reduction of nitro-compounds by means of zinc-powder, with or without the aid of iron, and in saline solutions. Dr. Dechend. D, No. 2927.

Preparation of a methyl-gallic ether and of a derived colouring-matter. Kern and Sandoz. K, No. 5468.

Preparation of red, violet, and blue colours by means of the tetrazo-derivative of ortho-diamido-diphenic acid. Baden Aniline Co. B, No. 7141.

Improvement in preparation of azo-colours. E. Kegel. K, No. 5613.

Preparation of soluble indulines. Dahl and Co. D, No. 3149.

Preparation of a blue azo-colour with diamido-stilbene. Berlin Aniline Company. A, No. 1643.

Preparation of blue azo-colours from diamido-stilbene. Berlin Aniline Company. A, No. 1662.

Improvement in the production of mixed azo-colours derived from tetrazo-diphenyl or tetrazo-ditolyl. Berlin Aniline Co. A, No. 1064.

Improvement in the production of mixed azo-colours derived from benzidine or tolidine and α-amido-naphthaline-δ-disulphonic acid. Berlin Aniline Co. A, 1724.

Preparation of bluish red azo-colours derived from benzidine or tolidine. F. Bayer and Co. F, No. 3163.

New mono-sulphonic acid from α-naphthol. Liebermann and Studer. L, No. 4327.

Preparation of ortho-nitrophenol. F. Bayer and Co. F, No. 3286.

Determination of Tannin.—Ch. Colin and L. Benoist.—This paper will be inserted at some length.

Process for Oil of Sesame.—E. Milliau.—By operating upon fatty acids obtained as above described, expelling the water by heating to 110°, and pouring them then into a test-tube upon an equal volume of hydrochloric acid mixed with sugar, we obtain a rose colour if oil of sesame is present. If the olive oil is pure the mixture remains colourless.

Manufacture of Tofu in Japan.—From the *Journal of the Society of Arts.*

Industrial Society of Mulhouse.—Session of the Chemical Committee, January 11, 1888.

E. Dollfus remarked, concerning the double salt of antimony fluoride with ammonium sulphate, that it fixes tannin perfectly, but notwithstanding the addition of sodium carbonate, the dunging process may have an unfavourable action upon certain colours associated with the tannin colours. Thus, berry-yellows lose their intensity. This action, however, is especially manifested at a temperature above 50°.

M. Noelting handed in, on behalf of Dr. Otto Witt, a memoir on the constitution of the colouring-matters of the groups of the azines, of the azonium bases, and of the saffranines.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Detection of Cotton Fibre.—Could any of your readers oblige by describing a method (reliable) for the detection of cotton in white or coloured woollen stuffs?—J. E. G.

MEETINGS FOR THE WEEK.

Monday, 14th.—Society of Arts, 8. "Decoration," by G. Aitchison, A.R.A.

Tuesday, 15th.—Institution of Civil Engineers, 8.
— Pathological, 8.30.
— Society of Arts, 8. "Duty of the State towards Emigration," by James Rankin, M.P.
— Royal Institution, 3. "The Plant in the War of Nature," by Walter Gardiner, M.A.

Wednesday, 16th.—Meteorological, 7.
— Pharmaceutical, 11. (Anniversary).
— Society of Arts, 8. "Electric Lighting from Central Stations," by R. E. B. Crompton.

Thursday, 17th.—Royal, 4.30.
— Royal Institution, 3. "The Chemical Arts," by Professor Dewar, M.A., F.R.S.
— Parkes Museum, 5. "Healthy Clothing," by Lewis R. S. Tonalin.
— Chemical, 8. Ballot for the Election of Fellows. "Researches on the Constitution of Azo- and Diazo-derivatives. IV. Diazo-amido Compounds," by Prof. R. Meldola, F.R.S., and F. W. Streatfield, F.I.C.

Friday, 18th.—Quekett Club, 8.
— Royal Institution, 9. "La Reproduction Artificielle des Roches Volcaniques," by M. Alphonse Renard, LL.D.

Saturday, 19th.—Royal Institution, 3. "The Later Works of Richard Wagner," by Carl Armbruster.

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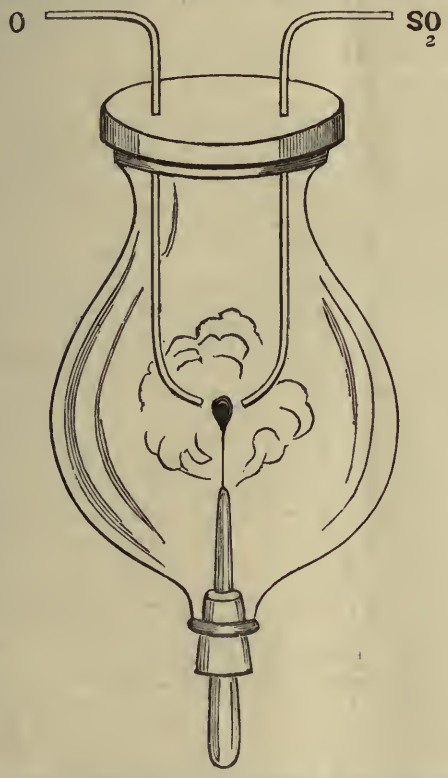
THE CHEMICAL NEWS.

Vol. LVII. No. 1486.

A NEW LECTURE APPARATUS FOR MAKING SULPHURIC ANHYDRIDE.

By Dr. W. R. HODGKINSON and F. K. LOWNDES, F.C.S.

We have lately designed a piece of apparatus which exhibits in a most striking manner the oxidation of SO_2, by means of oxygen in presence of spongy platinum, and which we think will be of interest and use to other lecturers. It consists, as the sketch will show, of an inverted bell-jar having an aperture at each end; through the lower one is pushed a caoutchouc stopper having passed through its centre a small rod of wood, attached to the upper end of which is a piece of moderately thick platinum-wire, holding in its position in the centre of the jar a block of spongy platinum. The upper aperture of the bell-jar is closed with a well-fitting but not fixed



piece of wood, through which are pushed two glass tubes bent at right angles outside, and inside curved so as to impinge on to the platinum, as shown. The block of sponge is raised to a moderately high temperature in a Bunsen flame, and pushed into its place; streams of oxygen (or even air) and sulphur dioxide are then passed through their respective tubes: instantly the globe becomes filled with vapour of sulphur trioxide, and if the supply of gases is steady, and not too violent, a large quantity of this substance can be made in a very short space of time. The experiment is still more striking if the SO_2 be passed for a short time before starting the oxygen, or *vice versâ*.

Royal Military Academy, Woolwich,
May 7, 1888.

ON THE ANALYSIS AND COMPOSITION OF ANTIMONIUM POTASSIUM OXALATE.

By PERCY KAY.

Having had occasion recently to determine the amount of antimony in a sample of double oxalate of antimony and potassium, of undoubted purity, I was surprised to find a considerably higher proportion of antimony than corresponds to the formula $K_3Sb(C_2O_4)_3 6H_2O$, which requires 19·71 per cent Sb. The amount found was 24·84 per cent. I therefore thought it would be of interest to make a complete analysis. The following methods were used.

(*a*) *Estimation of the Antimony.*—5 grms. of the substance was dissolved in water and diluted to 500 c.c. 50 c.c. (1 grm.) were taken, tartaric acid solution added in excess, excess of acid nearly neutralised with sodium carbonate, then 20 c.c. of a saturated solution of potassium bicarbonate added. An excess of calcium hypochloride of known strength was next added, the excess being found by arsenite solution of known strength, until the liquid ceased to give a blue colour with starch iodide paper. The strength of the bleaching solution was found by titration with arsenite, starch iodide paper being used as indicator. The arsenite solution contains 5 grms. As_2O_3 per litre. 1 c.c. = 0·006 grm. Sb = 0·0072 grm. Sb_2O_3.

(*b*) *Potassium.*—2 grms. of the substance was ignited at a low red heat, by which means the oxalates are converted into carbonates. The mass was extracted with water, and the solution titrated with standard sulphuric acid and methyl orange. 1 c.c. = 0·039 grm. K (results slightly below true amount). A preferable method is to precipitate the antimony with ammonia, filter, evaporate filtrate to dryness, ignite, dissolve in water, and titrate with acid as before.

(*c*) *Water.*—The substance (2 grms.) was dried at 100° C. till constant. Time required about two hours.

(*d*) *Oxalic Acid.*—50 c.c. of the solution were acidified with acetic acid, calcium chloride solution added, the solutions heated on water-bath for about three hours, solution filtered, precipitate washed with hot water until washings were free from chlorine. A hole was then made through the filter, the greater part of the precipitate washed into a flask, residue on filter dissolved into the flask by means of hot dilute hydrochloric acid. Sulphuric acid is now added, and the contents of the flask heated to 60° C., titrated with N/10 $KMnO_4$. 1 c.c. = 0·0044 grm. C_2O_4.

Calculated to the formula $K_4Sb_2(C_2O_4)_6 \cdot 3H_2O$—

	Found. Per cent.	Calculated. Per cent.
Potassium	15·21	15·94
Antimony	24·84	24·54
Oxalic acid (C_2O_4)	54·03	53·98
Water	5·85	5·54
	99·93	100·00

Calculated to $K_3Sb(C_2O_4)_3 \cdot 6H_2O$—

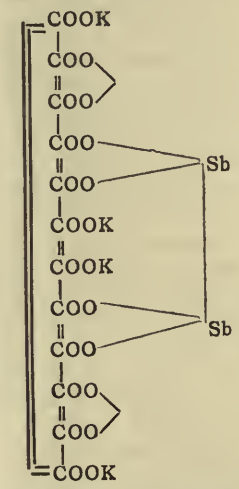
	Per cent.
Potassium	19·21
Antimony	19·71
Oxalic acid (C_2O_4) ..	43·35
Water	17·73
	100·00

The substance was next re-crystallised and dried and again analysed.

Calculated to $K_4Sb_2(C_2O_4)_6$—

	Found. Per cent.	Calculated. Per cent.
Potassium	16·57	16·88
Antimony	26·23	25 98
Oxalic acid (C_2O_4)	57·11	57·14
	99·91	100·00

The specimen was manufactured by Casella and Co. It may be perhaps represented constitutionally by the following formula:—



A second sample (Rudolf Koepp, Castrick in Rheingau) gave the following results on analysis by the above methods.

Calculated to formula $K_3Sb(C_2O_4)_3.2H_2O$—

	Found. Per cent.	Calculated. Per cent.
Water	6·30	6·71
C_2O_4	53·15	49·16
Sb..	20·96	22·34
Potassium	19·69	21·79
	100·10	100·00

The potassium was found by precipitating the antimony by ammonia, filtering, evaporating to dryness, igniting, and titrating with acid as before.

The antimony in this sample was estimated by dissolving in water and titrating with N/10 KHO, phenolphthaleine being used as indicator (pink colour). 1 c.c. = 0·004 grm. Sb.

By the arsenite process 21·12 per cent of antimony was found.

This second sample was stated to correspond to the formula $K_3Sb(C_2O_4)_3.6H_2O$. The water was determined at 100° C.

Technical College, Bradford.

THE RELATIONS BETWEEN THE ATOMICITY OF THE INORGANIC ELEMENTS AND THEIR BIOLOGICAL ACTION.

By Dr. J. BLAKE.

The author has found, when studying the biological action of a great number of inorganic compounds when injected into the circulatory system of living animals, certain very interesting facts, depending on the molecular properties of the substances employed.

He has demonstrated, in a memoir read before the Academy long ago, that the biological action of these in organic substances is determined by the electro-positive element of the salt employed. He has since shown that the biological action of such substances is connected with the isomorphic relations of the elements; that all substances forming one and the same isomorphous group have a similar biological action; and that in each isomorphous group the intensity of the biological action is a function of the atomic weight (*Comptes Rendus*, xcvi., p. 409).

He proposes at present to call attention to certain interesting relations which exist between the atomicity of the elements and the reactions which they produce in living matter. His experiments have been made with the monoatomic, diatomic, triatomic, and tetratomic elements.

Among the monoatomic elements he has studied the action of the salts of lithium, sodium, rubidium, silver, cæsium, and thallium; among the diatomics, that of the salts of magnesium, chromium, manganese, iron, cobalt, nickel, copper, zinc, and cadmium, and also that of the salts of calcium, strontium, barium, and lead; among the triatomics the action of salts of aluminium of iron (ferricum), of gold, yttrium, cerium, (Ce_2O_3), lanthanum, erbium, and didymium; and among the tetratomics the salts of platinum, palladium, cerium, (CeO_2), thorium, uranium, and titanium.

Among elements having the same atomicity there are found some belonging to different isomorphic groups. The biological action of these different elements is not identical in several respects, but we find that the atomicity of an element is always an important factor as regards the extent of its biological action, or as to the number of organs to which its action extends. Among the elements whose salts have not all the same atomicity it is always the salt having the strongest atomicity whose biological action is the most extended,—a fact ascertained on comparing the action of the thallous and thallic, ferrous and ferric, cobaltous and cobaltic, cerous and ceric salts. The monoatomic elements, when injected into veins in physiological doses, kill by their action upon the pulmonary arteries. They can circulate in the blood without giving rise to any decided reaction upon the nerve-centres. Even if injected into the carotid so that they arrive at the nerve centres in a state of considerable concentration, they do not at all disturb the functions of the brain, the bulb, or the spinal marrow.

The biatomic elements consist of two isomorphous groups whose biological action differs in several respects, but all the biatomic elements differ from the monoatomic elements by causing more extended biological reactions. The salts of the magnesian and the barytic group kill by paralysing the heart, but those of the magnesian group act also upon the centre of vomiting, and those of the barytic group upon the voluntary muscles, the irritability of which they keep up long after death. The triatomic elements have a much more generalised biological action. The respiratory, vasomotor, and inhibitory centres, and the cardiac ganglia, are all more or less affected. Besides nearly all these elements act upon the pulmonary arteries.

The tetratomic elements produce upon the nerve-centres reactions still more pronounced, especially as regards the respiratory and vasomotor centres. Sensibility and the reflexes are abolished before the dose is strong enough to arrest respiration, and all, if injected into the veins, determine the contraction of the pulmonary arteries.

The following table sums up the facts just explained:—

Monoatomic Elements.—Action upon the pulmonary arteries.

Biatomic Elements.—Action upon the centres of vomiting and upon the voluntary and cardiac muscles. The only diatomic element which acts upon other nerve-centres is glucinum, an element which in its oxygen compounds seems to occur in a trivalent form,—a point upon which chemists are not agreed.

Triatomic Elements.—Action upon the respiratory, vasomotor, and inhibitory centres, upon the cardiac ganglia and the pulmonary arteries.

Tetratomic Elements.—Action upon the respiratory, vasomotor, and inhibitory centres, upon the brain, the spinal marrow, the cardiac ganglia, and the pulmonary arteries.

The facts just mentioned enable us to establish a further link between the chemical constitution of the elements and their biological action.

The author has already demonstrated the important part played by isomorphism and atomic weight in acting upon living tissues, and we may now also regard atomicity as another important factor. These relations may furnish important assistance in researches in molecular chemistry. It must not be forgotten that when Mr. Newlands published the "periodic law" he made the interesting observation that all the elements which are found in organised bodies have atomic weights below 40. It may now be added that all the electro-positive elements found in organised bodies are monoatomic or diatomic.—*Comptes Rendus*, cvi., 1250.

RESEARCHES ON ALLOISOMERISM.*

I.

By ARTHUR MICHAEL.

(Continued from . 187).

Behaviour of Chlorfumaric Acid towards Aniline.

FIVE grms. of monochlorfumaric acic (melting-point 183°: obtained by the action of phosphorus pentachloride on tartaric acid) were dissolved in one hundred grms. of water, and two and one-half grms. of aniline added. The aniline went into solution, and presently a crystalline substance separated. For analysis it was crystallised twice from alcohol.

0·2736 grm. air-dried substance gave 0·1610 grm. AgCl.

	Theory for $\begin{matrix}CCl—COONH_6C_6H_5\\ \vert\\ CH—COOH.\end{matrix}$	Found.
Cl	14·57	14·55

Acid aniline chlorfumarate crystallises from alcohol as white monoclinic prisms with domes, that melt at 178°, but begin to turn yellow at about 170°. It is difficultly soluble in cold water and alcohol, but readily in chlorhydric acid, when it decomposes into chlorfumaric acid and aniline chlorhydrate. This salt or its aqueous solution may be allowed to stand for weeks with water without undergoing any change. An aqueous solution of the salt behaves on boiling like the corresponding bromfumaric acid salt; only its conversion into the anil of phenylamido-maleic acid proceeds with less readiness. When a solution of the salt is boiled a number of minutes, the unchanged salt is deposited on cooling. If the boiling is continued for some time the solution gradually turns yellow, and the yellow anil begins to separate. This was purified as already described, and gave the same compound as obtained from brommaleic and bromfumaric acids.

0·1573 grm. substance gave 0·4195 grm. CO_2 and 0·0677 grm. H_2O.

	Theory for $\begin{matrix}CNHC_6H_5—CO\\ \vert\\ CH \quad —CO\end{matrix}\Big> C_6H_5.$	Found.
C	72·73	72·76
H	4·55	4·79

The formation of the same compound from brommaleic, brom- and chlorfumaric acids when aqueous solutions of their neutral aniline salts are boiled, is of considerable theoretical importance, as it implies the conversion of derivatives of fumaric acid into a maleic acid compound at the temperature of boiling water, a fact that can only be brought in harmony with Fittig's views of the constitution of these compounds with the assumption of improbable inter-molecular changes. I shall return to the subject in a discussion of the bearings of the present investigation on the constitution of the acids in question.

Behaviour of Dibrommaleic Acid towards Aniline.

This reaction is complicated, and, acccording to the conditions of the experiment, a number of different products are formed, which, however, are difficult to obtain in a pure state.

To a solution of the acid in thirty parts of water an equivalent proportion of aniline was added. The base dissolved, and immediately the very difficulty soluble acid aniline dibrommaleate was deposited. This salt dissolves in dilute chlorhydric acid, to form the free acid and aniline chlorhydrate. If it is allowed to stand under water for a number of days it gradually loses water to form an anilide, which decomposes when heated with water or other solvents, and could not be obtained in a state suitable for analysis. The neutral salt, formed on adding two equivalents of aniline to a solution of one of the acid, is also quite insoluble. It dissolves in dilute chlorhydric acid. When allowed to stand under water for a long time it also passes over into an anilide that may be separated from any unchanged salt by treating with dilute chlorhydric acid. This salt, when heated in a solvent, goes over into a mixture of a yellow substance that is described further on, and unchanged substance. As it was found impossible to crystallise the substance without its undergoing a partial change, it was dried in a vacuum and analysed.

0·2224 grm. substance gave 0·2041 grm. AgBr.

	Theory for $\begin{matrix}CBr—CONHC_6H_5\\ \vert\\ CBr—CONHC_6H_5.\end{matrix}$	Found.
Br	37·73	38·98

The substance probably contained a small amount of the anil, but the analysis is sufficiently close to show that the product analysed consisted largely of the dianilide. It was obtained as plates that melted at 138°—140°. The anil is probably obtained by crystallising the anilide, obtained from the acid aniline salt, from ligroin. The solution, on cooling, deposited large white plates, but as they were mixed with yellow needles, and as no satisfactory way could be found to separate the two compounds, no analyses were made. It melts at 160°—162°, and is insoluble in dilute chlorhydric acid.

The yellow compound may be obtained in a pure state by heating three parts of acid in sixty parts of water and 2·2 parts of base for about half an hour, and filtering hot from the reddish yellow precipitate. This was extracted with a small amount of hot alcohol that dissolves some of the substance and most of the dark impurities. The residue was purified by three crystallisations from hot alcohol.

0·1949 grm. substance dried at 100° gave 0·1066 grm. AgBr.

0·2285 grm. substance dried at 100° gave 0·1260 grm. AgBr.

	Theory for $\begin{matrix}CNHC_6H_5—CO\\ \vert\\ CBr \quad —CO\end{matrix}\Big> NC_6H_5.$	Found.	
Br	23·29	23·32	23·46

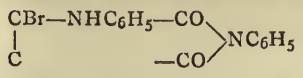
The anil crystallises from alcohol as flat prisms with end-faces generally at right angles, but in some crystals they obliquely truncated the sides. They melt (under decomposition) at 182°—183°. When large the crystals have a reddish yellow colour, but as a powder or as very small crystals it is almost pure yellow. They are insoluble in hot water, and only moderately soluble in hot alcohol. Dilute chlorhydric acid and dilute alkalies do not dissolve them.

$$\begin{matrix}CBr—COONH_3C_6H_5\\ \vert\\ CBr—COONH_3C_6H_5\end{matrix} + NH_2C_6H_5 = \begin{matrix}CNHC_6H_5—CO\\ \vert\\ CBr \quad —CO\end{matrix}\Big> NC_6H_5 + 2H_2O + C_6H_5NH_3Br.$$

The formation of this substance is of interest because it shows that dibrommaleic acid can hardly have the commonly accepted constitution. If both the bromine atoms were united with the same carbon there is every reason for supposing that a substance free of halogen

* *American Chemical Journal*, Vol. ix., No. 3.

would have resulted from the reaction, as the compound



would, judging from what we know of the properties of this class of substances, hardly show the stability of the substance in question, but would decompose into a substance free of halogen and bromhydric acid.

A substance free of halogen and crystallising as dark red plates may be obtained by heating the acid in aqueous solution with a large excess of aniline. I did not succeed, however, in getting it into a state suitable for analysis.

Behaviour of Bromcitraconic Acid towards Aniline.

Bromcitraconic anhydride (melting-point 99°—100°) was dissolved in twenty parts of water, and an equivalent of aniline added to the solution. The base dissolved and a crystalline precipitate was immediately deposited. This substance was filtered, washed with water, and analysed.

0·2461 grm. substance dried in vacuum gave 0·1556 grm. AgBr.

	Theory for $CH_3—C(CBr—COONH_3C_6H_5)—COOH$.	Found.
Br	26·91	26·50

The acid aniline bromcitraconate crystallises in clusters of small white rhombic plates that melt at 120°—121°, turning yellow. It is soluble in dilute chlorhydric acid, but careful neutralisation of the solution with ammonia throws down the original substance. It is somewhat soluble in cold water.

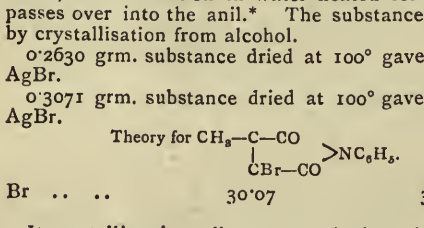
If this salt is allowed to stand under water for a few hours, or its solution in water heated for a minute, it passes over into the anil.* The substance was purified by crystallisation from alcohol.

0·2630 grm. substance dried at 100° gave 0·1871 grm. AgBr.

0·3071 grm. substance dried at 100° gave 0·2197 grm. AgBr.

	Theory for $CH_3—C(CBr—CO)>NC_6H_5$.	Found.	
Br	30·07	30·26	30·41

It crystallises in stellar groups of prismatic needles that melt at 144·5°—145·5°, and are insoluble in cold, slightly in warm water. They are readily soluble in hot, moderately in cold alcohol, and are insoluble in dilute chlorhydric acid.



(To be continued.)

City and Guilds of London Institute.—Technical College, Finsbury.—The Annual Students' Conversazione will be held on Friday, May 25th, 1888, commencing at 7 p.m. A lecture will be delivered by Professor S. P. Thompson on "Polarisation of Light," and a lecture will also be delivered by Professor J. Perry, on "Magnifying Springs." A Concert will be given during the evening, and there will be an Exhibition of Drawings, Apparatus, &c. Tickets may be obtained from the Office of the College, or from the Hon. Secs., Messrs. W. D. Conning and P. V. McMahon.

* Through a mistake on my part this substance was represented as the acid anilide in the preliminary note, *Berichte*, xix., 1373.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, May 3rd, 1888.

Mr. William Crookes, F.R.S., President, in the Chair.

Certificates were read in favour of Messrs. Joseph Campbell, Glen Innes, New South Wales; John Dunn, Myrtle Cottage, Downfield, Dundee; William Burns Featherstone, Showelhurst, Moseley, Birmingham; Albert L. Guiterman, Ph.D., 36, Primrose Hill Road; James C. Hamilton, King's Cavil, Linlithgow, N.B.; James Mair, B.Sc., 181, Hospital Street, Glasgow, S.S.; Edward William Alfred Augustine Mayhew, Freemantle, Western Australia; John James Morgan, Highfield House, Ebbw Vale, Monmouth; Frederick Ernest Pollard, Administration des Services Sanitaires et d'Hygiène Publique, Cairo, Egypt; Albert John Sach, Goulburn, New South Wales, Australia; Mark S. Wade, M.B., Clinton, British Columbia.

The following papers were read:—

36. "*The Determination of the Molecular Weights of the Carbohydrates.*" By Horace T. Brown and G. Harris Morris, Ph.D.

The molecular weights of the carbohydrates have, with one or two exceptions, never been determined with any certainty. The exceptions—dextrose and levulose—have been shown indirectly by Kiliani to have a molecular weight corresponding to the formula $C_6H_{12}O_6$. The generally accepted views with regard to the other carbohydrates are based entirely upon certain indefinite derivatives, and only give the *minimum* size of the molecules. Quite recently V. Meyer (*Ber.*, 1888, 556) and Auwers (*ibid.*, 1888, 860) have drawn attention to the method devised by Raoult for the determination of molecular weights. The method is applicable to all organic substances, and is of especial value in cases where a vapour-density determination is not possible. Blagden, in 1788, established the fact with regard to inorganic salts that the lowering of the freezing-point of their aqueous solutions is proportional to the weight of substance dissolved in a constant weight of water. De Coppet, in 1871-72, extended these results, and pointed out that when the lowering of the freezing-point is calculated for a given weight of the substance in 100 grms. of water, the result, which he terms the *coefficient of depression*, is constant for the same substance, and that the coefficients for different substances bear a simple relation to their molecular weights.

Raoult extended the law to organic substances and to other solvents besides water. He showed that when certain quantities of the same substance are successively dissolved in a solvent upon which it has no chemical action, there is a progressive lowering of the point of congelation of the solution, and this lowering is *proportional to the weight of the substance dissolved in a constant weight of water.* If C be the observed depression of the point of congelation produced by x grms. of the substance dissolved in y grms. of the solvent, then the depression A produced by 1 grm. of the substance in 100 grms. of the solvent is given by the formula—

$$\frac{C \times y}{x \times 100} = A.$$

If the value A, which Raoult designates the "coefficient of depression," of the respective substance for the respective solvent is multiplied by the molecular weight M of the dissolved substance, we get $M \times A = T$, the so-called "molecular depression" of the substance in question. T is a value varying with the nature of the solvent, but remaining constant with the same solvent for numerous groups of compounds. Raoult finds that for

water T = 19 for all organic substances with one or two exceptions. From this it follows that having determined experimentally the value of A for any substance, and knowing the value of T, the molecular weight M for the substance in question may be obtained by dividing A into T : for $M = \frac{T}{A}$.

The method employed by the authors is essentially that of Auwers (*Ber.*, 1888, 712), the solvent employed being necessarily water. The thermometer used is graduated into twentieths of a degree centigrade, and with the aid of a telescope can be easily read to 1-200th of a degree.

The following results were obtained :—

Dextrose. Calculated for $C_6H_{12}O_6$.	Found (mean).
A = 0·106	A = 0·1052
M = 180·0	M = 180·2

Cane-sugar. Calculated for $C_{12}H_{22}O_{11}$.	Found (mean).
A = 0·0555	A = 0·0562
M = 342·0	M = 337·5

Maltose. Calculated for $C_{12}H_{22}O_{11}$.	Found (mean).
A = 0·0555	A = 0·059
M = 342·0	M = 322·0

Milk-sugar. Calculated for $C_{12}H_{22}O_{11}$,	Found (mean).
A = 0·0555	A = 0·055
M = 342·0	M = 345·0

A solution of cane-sugar inverted with *invertase* gave before inversion M = 328, after inversion M = 174·3 : clearly showing that 1 mol. of cane-sugar splits up on inversion into two equal molecules.

It was found that dextrose which exhibits birotation in solution has the same molecular weight as dextrose having the normal rotation.

Mannitol. Calculated for $C_6H_{14}O_6$.	Found (mean).
A = 0·104	A = 0·105
M = 182·0	M = 181·0

Arabinose. Calculated for $C_5H_{10}O_5$.	Found (mean).
A = 0·126	A = 0·1263
M = 150·0	M = 150·3

Raffinose. Calculated for $C_{18}H_{32}O_{16}{\cdot}5H_2O$.	Found (mean).
A = 0·032	A = 0·036
M = 594·0	M = 528·0

All the results are the mean of numerous extremely concordant experiments made with solutions of varying concentration.

All the saccharoses—cane-sugar, maltose, and milk-sugar—were found to have the same molecular weight, thus disproving the suggestions of Herzfeld and others as to their varying values.

The authors have applied the method to starch and the non-crystallisable products of its transformation, but owing to unexpected diffiulties, resulting from the smallness of the value of A for these substances, they are unable as yet to assign accurate values to them, although there can be no doubt that their molecular weights are extremely high.

Numbers confirming this statement are promised for an early meeting of the Society.

37. "*The Molecular Weights of Nitric Peroxide and Nitrous Anhydride.*" By W. Ramsay, Ph.D.

The author has applied Raoult's method of determining molecular weights to nitric peroxide, and has ascertained the depression produced in the freezing-point of pure glacial acetic acid by quantities of peroxide varying from 0·92 grm. to nearly 9 grms. of peroxide to 100 grms. of acetic acid. It is found that in every case the molecular weight of the peroxide is nearly 92, corresponding to the formula N_2O_4; the highest result was 98·58, and the lowest 90·29. These experiments establish the molecular weight of liquid nitrogen peroxide, even in dilute solution, and also show that no further molecular aggregation occurs even when the number of molecules of peroxide in a given volume is considerably increased.

Similar experiments were made with nitrous anhydride, but the temperature of experiment (about 16°) is so high that dissociation occurred during manipulation. No definite results were obtained.

Discussion.

Prof. Debus said he presumed that on dissolving urea in acetic acid combination would occur. Would the molecular weight found be the same if a neutral solvent were used? Also, did not acetic acid act on nitrogen tetroxide? Most liquids exerted a decomposing action on this substance. He was under the impression that Raoult's method involved the use of a solvent which had no chemical action on the substance.

Mr. Wynne remarked that the molecular weight of acetic acid determined by Raoult's method accorded with the formula $C_2H_4O_2$. Now it was known that the vapour-density of acetic acid at a few degrees above its boiling-point pointed to the formula $C_4H_8O_4$, and that it was only at higher temperatures that the less complex molecule $C_2H_4O_2$ was obtained. It must therefore be assumed that the action of the solvent resulted in the complete dissociation of the complex molecules present in liquid acetic acid. Most results hitherto obtained by the use of Raoult's method pointed to a similar complete dissociation, and would seem to show that the dissociation is not dependent on the particular solvent employed, but took place in all cases; the method, therefore, had so far failed to afford any indication of the molecular complexity of liquids and solids.

Referring to the formula $C_{12}H_{22}O_{11}$ deduced by Messrs. Brown and Morris by Raoult's method, Mr. Wynne asked what interpretation was to be placed on the results recently obtained by Winter in his investigation of the specific rotatory power of levulose and of invert sugar, which pointed to the presence in the latter of 3 mols. levulose and 4 mols. dextrose. If these results were accepted it would seem reasonable to suppose that the complexity of the molecule of cane-sugar was greater than that indicated by the formula quoted.

Dr. Perkin said that he had obtained results confirmatory of those brought forward. Using acetic acid as solvent, the molecular weight of naphthalene was found to be 134, and the values he had obtained for the isomeric citraconic, itaconic, and mesaconic acids were respectively 130·6, 130·9, and 138, the calculated value for the simple formula $C_5H_6O_4$ being 130.

Mr. Crompton observed that great irregularities were manifest on comparing the molecular depressions of various substances as determined by Raoult; therefore, until more was known of the cause of such irregularities and of the mechanism of the changes under discussion, such results as those brought forward by Messrs. Brown and Morris must, he thought, be accepted with great reservation.

Dr. Armstrong said that the results obtained by Raoult's method were certainly very striking, but bearing in mind the complexity of the phenomena of dissolution, as there was undoubtedly much evidence to favour the conclusion that the molecules of many substances in the solid and even in the liquid state were congeries of the *fundamental* molecules, he was not prepared to accept the conclusions arrived at as in any way final. If Winter's results were accepted it would be difficult to reconcile them with the conclusion that cane-sugar was represented by the simple formula $C_{12}H_{22}O_{11}$. Apart from the in-

formation as to the comparative molecular weights of dissolved substances which Raoult's method promised to afford, it appeared that in order to gain as complete insight as possible into the molecular composition of solids and liquids it was important to vary in every way the proportions of substance dissolved as well as the solvent: he therefore regarded V. Meyer and Auwers' recent recommendation of acetic acid as the solvent as most unfortunate.

Mr. Heron doubted the correctness of Herzfeld and Winter's determinations of the rotatory power of levulose.

Mr. Brown agreed with Mr. Heron that Winter's statement regarding levulose required confirmation. The values obtained by Raoult were remarkably uniform for members of a group of compounds, and he was of opinion that the general consistency of the results obtained in the case of organic compounds was such as entirely to justify the claim that the results put forward by Mr. Morris and himself were to be accepted as expressing the facts.

Prof. Ramsay asked, Was urea acetate known? [Beilstein does not mention it, although he describes the trichloracetate. Gmelin says that the lactate cannot exist, and states that urea does not combine with weak acids. Moreover, its formation would not materially affect the result, as it would only be equivalent to the withdrawal of a small portion of the acid.] N_2O_4 was without action on acetic acid; it, however, served as a most delicate test of water, a green colour being produced if water were present in the acid. He agreed that as great a variety of solvents as possible should be used.

38. "*The Action of Heat on the Salts of Tetramethylammonium.*" By A. Th. Lawson, Ph.D., and Norman Collie, Ph.D., F.R.S.E.

The research was undertaken to ascertain how the tetramethylammonium salts would behave when heated, and in what respects they would resemble the phosphonium and sulphine compounds. Most of the salts experimented with were found to be very deliquescent and far more soluble than the corresponding ammonium salts, and when compared with the ammonium salts the order of solubility seemed in some cases to be reversed: in the case of the halogen salts the iodide is least soluble, the chloride and fluoride the most soluble. The oxalate and sulphate are extremely deliquescent, while the nitrate is one of the least soluble of the tetramethylammonium compounds and scarcely deliquescent. Nearly all the salts experimented on split up in a simple manner, trimethylamine and a salt of methyl being produced. The fluoride is an instance: $(CH_3)_4NF=(CH_3)_3N+CH_3F$. But in some cases where the decomposition takes place at a high temperature and the methyl salt which is formed is not very stable, further decomposition occurs: of this kind of decomposition the nitrite is an example:—

$$4(CH_3)_4N\cdot NO_2=4(CH_3)_3N+2(CH_3)_2O+4NO+O_2.$$

39. "*The Action of Heat on the Salts of Tetramethylphosphonium.*" By Norman Collie, Ph.D, F.R.S.E.

The action of heat on the salts of tetramethylphosphonium was studied, partly to complete a series of experiments which had been made on the mode of decomposition of the phosphonium salts when heated, and partly to compare their decomposition with that of the tetramethylammonium salts when similarly treated.

The salts of tetramethylphosphonium with the oxyacids, when subjected to the action of heat, undergo, as a rule, two different changes: the first, and by far the most important, is the production of trimethylphosphine oxide and a ketone—in the case of the benzoate:—

$$(CH_3)_4PCO_2C_6H_5=(CH_3)_3PO+CH_3\cdot CO\cdot C_6H_5.$$

The second change, and one which only occurs to a very limited extent, is when trimethylphosphine and a salt of methyl are produced:—

$$(CH_3)_4PCO_2C_6H_5=(CH_3)_3P+C_6H_3\cdot CO_2C_6H_5.$$

As regards the action of heat on the hydracid salts, the chloride is the only one which decomposes in a simple manner:—$2(CH_3)_4PCl=2(CH_3)_3PHCl+C_2H_4$.

Anniversary Meeting, March 28th, 1888.

Address of the President, William Crookes, F.R.S.*

On occasions like the present not a few of my predecessors have laid before the Society able and instructive surveys of the progress of chemical research, discovery, and invention. For two reasons I find myself debarred from following their example.

Of late we have been favoured with such plentiful summaries of advances in every department of Science that I feel unwilling to add to the number, lest I might be accused of producing an *Ilias post Homerum*.

And secondly, although a great quantity of sound and useful work has indeed been done since our last anniversary, yet with two exceptions—I fear I must say incomplete exceptions—we have not witnessed the dawn of any epoch-making, far-reaching discovery which opens out new and tempting prospects of truth. The two exceptions which I have ventured to call partial or incomplete, because they have not yet been fully verified, are the researches of Messrs. Krüss and Nilson on the so-called rare earths, and the investigations of Professor Grünwald of Prague. The result reached by Professor Grünwald in his mathematical discussion on certain spectral revelations seems at least to foreshadow the conclusion that hydrogen, oxygen, carbon, and magnesium are not simple bodies, but compounds. If the phenomena he records admit of no other explanation, and if no unexpected source of error is detected, we may consider ourselves to be within measurable distance of a truly "new chemistry." But here time must decide. Objections already have been raised to the conclusions of Professor Grünwald, and we are forewarned we must not allow ourselves to be carried away by our hopes and our sympathies.

To one event I must beg to draw particular attention,—the tardy justice accorded to Mr. J. A. R. Newlands, the painstaking discoverer of the periodic law of the Chemical Elements. Of the importance of this law it is utterly needless to enlarge. It has been universally accepted as a most valuable generalisation, as the grandest step in theoretical chemistry within the last quarter of a century. Mr. Newlands formulated and published this law in all its main features as early as 1864 and 1865, and was only ridiculed for his pains; yet four or five years later, when Professor Mendeléeff announced the same idea it was received as an original discovery. Original it was in the sense that Professor Mendeléeff was perfectly ignorant of what had been done by Newlands. The strangest thing in this curious history is the fact that in 1882 the Royal Society awarded "Davy Medals" to Professors Mendeléeff and Lothar Meyer, wholly ignoring the prior claims of Mr. Newlands. By degrees, however, the truth became known; and the prior claim of Mr. Newlands was admitted in Miller's "Elements" in 1878, whilst Dr. Tilden accepted it in his "Chemical Philosophy" in 1880, and Dr. Gladstone in his Presidental Address to the Chemical Section of the British Association in 1883. Mr. Newlands reprinted his original papers on this subject in 1884, giving the date of each paper. At length, in November last, better late than never, he received from the Royal Society the well-earned award of the Davy Medal. It would be unpardonable to overlook the energetic action of Professor Frankland in bringing about the recognition of Mr. Newlands' claims. He drew up a lucid and compact statement of the case, with all the necessary evidence, and appended the opinions, published and written, of many of the most eminent chemists.

Now this episode in the history of chemical discovery appears to me to convey a lesson worth noting. We see

* From the *Journal of the Chemical Society* for May, 1888.

that it is possible for an important discovery, even after full and formal publication, to be so thoroughly overlooked and forgotten, that when the same idea some years later is evolved by another and independent inquirer it passes as a striking and novel revelation.

Other occupants of the chair I have now the honor to fill have of late years discussed the position and prospects of scientific, technical, and especially of chemico-technical education. This is, doubtless, a most weighty subject. Seeing the multitude of chemical manuals we have produced, the schools and colleges and classes we have opened, and in particular the examinations we have instituted, we may fairly ask whether our returns of chemical discoveries and inventions are commensurate with all this stir and activity. Our chemical industries, we admit, are by no means in a satisfactory position. We know what systems of training prevail in the countries whose competition we have most cause to fear. We are perfectly aware in what respects these systems differ from our own. But, I may ask, what probability is there, after gleaning hints from our rivals, that we shall lay aside, or even modify, the plans we have taken up and so doggedly follow.

I cannot hely quoting here the opinion of an eminent writer in the *Guardian*:—"And yet man, who is so wise and good that he is always saying, like King Alphonso of Castile, 'Had we been consulted on the creation of the world we could have arranged things better,' has invented competitive examination, which means suffering and pain for all, without even a compensatory 'survival of the fittest' or improvement of the race."

I must notice an unsatisfactory feature in our schools and colleges, to which Mr. Goschen has recently called attention in his inaugural address as Lord Rector of the University of Aberdeen. It is not a flaw in our curriculum or in our method of teaching, but something more deeply seated and less easily remedied. It is the little intellectual interest taken by the students in their studies. Mr. Goschen tells us of the abusive epithets applied in our schools and colleges to pupils who, "not content with doing their work, commit the heinous offence of being absorbed in it."

Now, in this country we have scientific men unequalled in the pure, devoted love of truth, to whom discovery is its "own exceeding great reward." Among the general run of our pupils and students there is, however, little of this enthusiastic temper, and it is, perhaps, on this very account that English educationists think it necessary to offer the stimulus of prizes and certificates, together with other accessories of the competitive system. But do not all these devices tend in the long run to increase that lack of intellectual interest which Mr. Goschen deplores, and are they not sorry substitutes for enthusiasm?

In close connection with the point just discussed there is another subject to which attention may usefully be drawn. I mean the degree of public estimation which chemistry at present enjoys. In his late Presidential Address delivered before the British Association, Sir Henry Roscoe remarked that science was less respected in Britain than in other civilised countries. A variety of facts lead me to suspect that chemistry in this sense is exceptionally unfortunate. For instance, until lately, two of the subjects for the matriculation examination at the University of London were "Natural Philosophy and Chemistry." Recently, by one of those odd alterations so often made in the curriculum of our institutions of higher education, this is changed. The subjects now demanded are—mechanics, which is compulsory for all, and, at option, one of three subjects, chemistry, or one of two departments into which physics is divided. Thus chemistry is no longer deemed indispensable!

It is to be regretted, also, that in the course adopted somewhat recently by certain of the licensing bodies of the medical profession with regard to the requirements of preliminary training in natural science, the candidate is now no longer required to study these branches in a college or school with recognised facilities for chemical or other natural science teaching, but may obtain that instruction from any person. At first sight this may appear to be a broad and liberal measure, but on reflection it is easy to see how such action on the part of licensing bodies is a direct encouragement of the pernicious system of "cram."

It is well known that some of our public schools had begun to introduce physics and chemistry into their ordinary courses, and that other schools were preparing to follow their example. But no inconsiderable check has been given to this reasonable movement by certain changes introduced at the Military School of Sandhurst, and by others about to be adopted in the school for the Royal Engineers and Artillery at Woolwich. According to the new code, whilst as many as 3000 marks each can be earned in Latin, French, and German, and in "compulsatory" and "optional" mathematics, the utmost possible number to be gained in physics and chemistry, which rank as "second class," is 2000 each! Hence the study of these subjects, which are not made compulsory, is heavily handicapped. Even youths possessing exceptional taste and ability for physical science, if they select such subjects, must either fail altogether, or come out lower in the successful list than if they had confined themselves to languages and mathematics. Hence physics and chemistry are much more rarely taken up. Nor does the mischief end here. The public schools which prepare boys for the admission examinations of Sandhurst and Woolwich will of course pay less attention to chemistry and physics, and may not impossibly feel inclined to drop them altogether. As *Nature* puts it:—"Good work in science pays less well than mediocrity in other subjects. The new regulations lower the standard of school work by constantly withdrawing from the science classes a large proportion of the best students." If the new regulations should be introduced at Woolwich, as is threatened, it will be somewhat farcical to speak of the Engineers and the Artillery as the "scientific branches" of the service.

(To be continued).

THE ROYAL SOCIETY.

Amongst other subjects exhibited and illustrated at the conversazione on May 9th, the following are of especial interest to our readers:—

Experiments on the Optical Demonstration of Electrical Stress.—Exhibited by Professor A. W. Rücker, F.R.S., and Mr. C. V. Boys, A.R.S.M.

These experiments are similar to those devised by Dr. Kerr, the arrangements being modified so as to render them suitable for exhibition in public.

Conductors of various forms are immersed in bisulphide of carbon and placed between crossed Nicol's prisms. When the conductors are oppositely electrified the medium is thrown into a state of stress, and the light which had been extinguished by the analysing prism is restored.

The various forms of conductors employed are—

Parallel cylinders, concentric cylinders, parallel planes, a plane and cylinder, and plates bent so as to represent a section of a Leyden jar.

Many of the phenomena exhibited by crystals in plane polarised light are imitated—*e.g.*, the black cross and the production of colours similar to those in Newton's rings. A bright field can be maintained by the introduction of a plate of selenite between the Nicol's, in which case the electrical stress is indicated by change of colour.

Large Electrical Influence Machine.—Exhibited by Mr. James Wimshurst.

It has 12 disks of 2 feet 6 inches in diameter, each disk carries 16 metal sectors. The machine is self-exciting in any condition of atmosphere. It shows large and perfect brush discharge at its terminals. With Leyden jars will give sparks 13½ inches in length.

Radio-Micrometer. — Exhibited by Mr. C. V. Boys, A.R.S.M.

This is probably the most delicate instrument for measuring radiant heat yet made. It consists of a circuit made of antimony, bismuth, and copper hung by an exceedingly fine fibre of quartz in a strong magnetic field. A scale model of the circuit, twenty times the size or 8000 times the weight, shows the construction of the suspended part of the instrument. The fibre, if magnified to the same extent, would still be finer than spun glass. The proportions of the several parts are those which have been found by calculation (confirmed by experiment) to give the greatest possible delicacy.

Experiments with Soap-bubbles.—Exhibited by Mr. C. V. Boys, A.R.S.M.

These experiments are arranged to show chiefly the power of an air film to prevent two bubbles from coming into real contact. Thus, among other experiments, the outer of two bubbles may be pulled out until it squeezes the inner one into a long oval, but no real contact takes place. An inner bubble filled with gas will carry up an outer one to which are attached a wire ring and other things without really touching it at all. A bubble will roll down a spiral groove also made of soap film, or jump one or two steps at a time down a spiral staircase made of soap film without touching the spiral film or being injured in the least.

Some of the experiments show the effects of diffusion, of vibration, of magnetism, or of electricity upon bubbles or groups of bubbles.

An Apparatus for Determining the Hardness of Metals or other Substances.—Exhibited by Mr. Thomas Turner, A.R.S.M., F.C.S., F.I.C.

This apparatus is a modification of the sclerometer used in determining the hardness of minerals. A polished surface of the metal or other material to be tested is brought underneath a weighted diamond, which is moved in such a manner as to produce a visible line on the smooth surface. The weight in grms. necessary to produce a standard visible scratch is taken as a measure of the hardness of the material.

A Coulomb Meter.—Exhibited by Prof. George Forbes, F.R.S.

Consists essentially of a conductor of iron wire in the form of a spiral, or a double ring with cross wires. Above the conductor a set of vanes is pivoted. This consists of a circular disc of mica with a hole in the centre in which is fixed a paper cone carrying at its apex a pinion with a concentric ruby cup. Round the circumference of the mica disc eight small cylinders of pith are fixed at equal distances, and eight vanes inclined at 45° to the mica disc are attached to the pith cylinders, these vanes being made of the thinnest mica. This set of vanes is supported by the ruby cup resting on a steel point fixed to the base of the instrument. The pinion engages with the first wheel of a train of wheelwork actuating the indexes, which show upon dials the number of revolutions made by the vanes.

The action of the instrument is very simple. The electric current passing through the iron conductor creates heat, which sets up a convection current in the air, and this causes the vanes to rotate about the vertical axis and drive the clockwork. The number of revolutions indicated on the dials is, through a considerable range of currents, an exact indication of the number of coulombs or ampère-hours which have passed through the conductor. The friction of the ruby cup on the pivot determines the smallest current which can be accurately measured, and the friction of the clockwork is barely perceptible. The resistance of a meter to read from 1 ampère upwards is 0·02 ohm.

The New Iridio Platinum Incandescent Gas Burner (Lewis and Sellon's patents).— Exhibited by Messrs. Johnson, Matthey, and Co.

Apparatus for the Isolation of the Element Fluorine.— Exhibited by Prof. T. E. Thorpe, F.R.S.

(*a*) Apparatus for the preparation of anhydrous hydrofluoric acid by heating acid potassium fluoride.

(*b*) M. Moissan's apparatus for the electrolysis of hydrofluoric acid.

Apparatus for Measuring the Changes produced by Magnetisation in the Dimensions of Rods and Rings of Iron and other Metals.—Exhibited by Mr. Shelford Bidwell, M.A., F.R.S.

The instrument exhibited is capable of measuring changes of length to a millionth of a millimetre or a twenty-five-millionth of an inch.

An *iron* rod when magnetised becomes (as is well known) at first slightly lengthened. But if the magnetising force is sufficiently increased it again contracts, and ultimately becomes actually shorter than when unmagnetised. A *cobalt* rod contracts under magnetisation, reaching a minimum length in a field of about 500 C.G.S. units, beyond which point it becomes longer. A *nickel* rod also contracts; the limit of its contraction not having been reached with the greatest magnetising forces yet used. *Bismuth* is slightly elongated in intense fields. See *Proc. Roy. Soc.*, vol. xliii. (1888), p. 406.

Experiments Illustrating Low-temperature Spectra in Connection with the Spectra of Meteorites.—Exhibited by Mr. J. Norman Lockyer, F.R.S.

(1). Spectra of Mg, Mn, Pb, Fe, Ba, &c., at the temperature of the oxy-coal-gas flame.

The brightest of the lines, bands, and flutings seen under these conditions are those seen in the spectra of uncondensed meteor-swarms (nebulæ, comets, "stars" with bright line spectra, and bodies of Group II.).

The bright edge of the fluting at 500 in the spectrum of magnesium is coincident with the chief line in the nebula spectrum. Usually only the remnant of the fluting is seen, but on one occasion, at Greenwich, it was recorded as a fluting in the spectrum of the Nebula in Orion.

The brightest manganese fluting is at wave-length 558, and the second in intensity is at 586. The latter is seen as a dark band in all bodies of Group II., but the one at 558 is not seen in all of them. In these cases it is marked by the bright carbon fluting beginning at wave-length 564, the second one remaining visible because there is no carbon fluting near it. It may be remarked that the second manganese fluting is the probable origin of the so-called D_3 line in the spectrum of γ Cassiopeiæ, the appearance of a bright line being due to contrast at the darkest edge of the fluting.

The line of manganese at 540 is seen in the spectra of most of the "stars" with bright lines.

Another case of masking is that of barium. The brightest band is at wave-length 515, and the second at 525. In some of the bodies of Group II., only the second band is seen, the first one being masked by the bright carbon fluting at 517.

(2). Photographs of spectra at the temperature of the oxy-coal-gas flame.

The spectra of Mg, Mn, Fe, Pb, Ba, Sr, Ca, Cr, Bi, Cd, and Al, with a comparison spectrum of air and calcium in each case.

(3). Experiment showing the conditions of disappearance of the C and F lines from the spectrum of hydrogen.

The tube exhibited was prepared by putting a small chip of sodium in one of the open ends and sealing off behind it. The other end being connected with a Sprengel pump, the tube was exhausted and the sodium gently warmed. After further exhaustion the pump was stopped, and under these conditions C and F were visible. The sodium being again heated, C and F gradually dimmed, and the structural spectrum of hydrogen appeared, the colour changing from red to blue. When C and F had disappeared the tube was sealed off. Under present conditions C and F are not seen in the spark without jar, but on putting the jar in the circuit they make their appearance. The condition for the absence of C and F

is that of maximum conductivity. The fact that the structure-spectrum can be derived from the ordinary spectrum, and vice-versa, proves it to be a true spectrum of hydrogen, and not an impurity spectrum.

The structure spectrum is of interest in connection with the meteoric hypothesis, inasmuch as some of the lines are apparently coincident with lines in the spectra of some of the "stars" with bright lines. But since some of the strongest lines are absent from the spectrum of the "stars" the coincidences are very probably accidental.

(4). Map of meteorite spectra at the temperature of the oxy-coal-gas flame.

The spectra of the flames of 16 meteorites have been observed, and on the map they are arranged in order, beginning with the irons and passing gradually to the most stony ones. Only lines of Fe, Mn, Na, K, Li, and Cu, and two flutings, one of iron, and one of manganese, are seen.

(5). Photographs of some of the meteorite flames are also exhibited, but at present the series is incomplete.

(6). Photograph of a composite spectrum of meteorites compared with the solar spectrum.

Two pieces of the Nejed meteorite were bound with wire to the two carbons of an arc lamp, so that they served as poles. A mixture of meteorites, both iron and stony, was then made, and a small quantity put on the lower pole. The plate being exposed, the current was made to pass and the spectrum photographed. One half of the slit was exposed to the meteorites, and the other half to the sun.

Exhibited by Mr. W. C. Roberts-Austen, F.R.S.:—

Specimens of Gold showing the effect of small quantities of impurity on the fracture of the Metal.

Exhibited by the Woodhouse and Rawson Electric Supply Company:—

Vernon Harcourt's New Pentane Standard Lamp.

New Carbon Microphone Button.

Samples of "Adamantine" Carbon.

New Chemical "Pole Indicator."

Holophotometer for measuring the intensity of a light all round.

Exhibited by the Edison and Swan United Electric Light Company:—

Edison and Swan Company's Safety Lamp for Miners.

The lamp consists of a storage battery of four cells enclosed in a strong teak box turned out of the solid and strengthened with metal bands; and a small Incandescent Lamp mounted on the side of the case, protected by a strong glass cover. The case is fitted with a hinged lid secured by a crossbar fastened with a safety-nut, and having a swivel handle.

The full size of the lamp is 7 inches by 4¼ inches, and the weight of the whole ready for use is about 7 lbs.

(1.) Lamp ready for use.

(2.) Battery withdrawn from the case, consisting of four cells or accumulators joined in series, the terminals being brought down the sides of the battery in the form of two contact plates which, when the battery is put into the case, make contact with two corresponding plates inside the case, and so convey the current from the battery to the small Incandescent Lamp.

(3.) Frame in which the battery stands while being charged with current from the Dynamo.

(4.) Hook for lifting out the battery.

(5.) Key for unlocking the nut.

(6.) Screwdriver used to remove the glass cover when replacing the Incandescent Lamp.

(7.) Pipette for filling the battery with acid.

(8.) Lamp with Fire-Damp Indicator attached.

Exhibited by the Schanschieff Electric Light and Power Company:—

Miners' Electric Safety Lamps.

(1). A three cell lamp capable of giving 1½ candle power for nine hours. Each cell contains 5 fluid ozs. of solution and consumes ⅜ lb. of zinc in forty-eight hours. The light is more than four times more powerful than that of the Clanny oil lamp, and its working cost is ⅝d. per shift of nine hours, or 3¾d. per week. The weight when fully charged is about 3¼ lbs. The elements consist of carbon and zinc, and the excitant is a mercurial solution of Mr. Schanschieff's invention.

(2 and 3). Four-cell batteries, one round and one square. Each cell contains 5 fluid ozs. of solution, and at a cost of 1d. furnishes a light of nearly 2 candle power for nine hours. The weight when fully charged is 4½ lbs.

(4). A 4 cell reversible battery, *i.e.*, put in or out of action by reversing it. The charge consists of 24 ozs. of solution, and giving a light of 2 candle power will burn from ten to twelve hours at a cost of 1d.

The batteries can be used for many purposes other than mining lamps, viz., for microscopical purposes, house lighting, photography, diving, railway lighting, gun firing, gas works, &c.

OBITUARY.

THE LATE PROFESSOR WROBLEWSKI.

We regret that we have to record the death of Dr. Sigmund Wroblewski, the Professor of Experimental Physics at the University of Cracow. While working in his laboratory, the late Professor was severely burnt through the accidental upsetting of a petroleum lamp, and unfortunately the wounds which he then received have been the cause of his lamented decease. Dr. Wroblewski was born in the year 1848, and studied first in the University of St. Petersburg, and subsequently continued his investigations at Strasburg. In 1882 he was appointed to the Chair of Experimental Physics in the University of Cracow, and has, since then, contributed considerably to our knowledge of the subject of the liquefaction of the permanent gases, and the behaviour of substances under high pressures and low temperatures. The valuable supplement to the work of Cailletet and Pictet, which is due to the labours of Professor Wroblewski, cannot be easily estimated, and we deplore the occurrence of the fatal accident which robs the scientific world of such an able experimentalist in this important department of chemistry.

By his earlier experiments on the liquefaction of the permanent gases he was able to determine the critical temperatures and pressures of oxygen and nitrogen, and also from his researches on the absorption of gases by liquids under high pressures proved that carbonic acid did not form the hydrate, $CO_2.H_2O$. In conjunction with Dr. K. Olszewski, he extended his investigations to a study of the behaviour of carbon bisulphide and alcohol at low temperatures, and succeeded in solidifying both these liquids. Nitrogen and carbon monoxide were liquefied under conditions similar to those employed in the case of oxygen, but liquefaction was attended with greater difficulty. By the rapid ebullition of liquid oxygen a temperature of about $-186°$ was obtained, and at this temperature the sudden expansion of compressed nitrogen caused it to form snow-like crystals, and hydrogen, at the same temperature, under a pressure of more than 100 atmospheres, was also obtained in the liquid condition. The low temperatures observed when these gases boil were registered by the aid of a galvanometer and a thermo-electric couple, and by their use he determined the boiling-points of the liquid nitrogen and hydrogen under known pressures. The insulating properties of liquid oxygen and nitrogen were recorded in a paper communicated to the *Comptes Rendus* in 1885, and in the following year he succeeded in determining the density and properties of liquefied air, and established the fact that atmospheric air, when in the

liquid state, behaves as a mixture. The atomic volumes and the densities of these gases were also first accurately determined by Professor Wroblewski, and his results have since been confirmed by more recent observers. The theoretical questions which arise out of researches of this nature also claimed his attention, and in a long paper published last year in the *Annales Phys. Chem.* he proposed that the relation of the physical properties of gases and liquids should in future be represented by curves showing the rate of change of pressure with temperature for different densities instead of by isothermal lines. These curves he called "isopyknics," and from inspection of the diagram of such "isopyknics" new and important conclusions were deduced. In diagrams of this nature the expansion of the substance by heat, and its compressibility, are expressed by the passage from one isopyknic to another either in a vertical or horizontal direction. This method of representing the phenomena accompanying the change of state of substances must therefore also be associated with the important experimental work by which the name of Wroblewski will be remembered.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of emperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 18, April 30, 1888.

Determination of the Combustion-heats of the Isomeric Acids, corresponding to the Formulæ $C_4H_4O_4$ and $C_5H_6O_6$.—W. Louguinine.—The author concludes that the constitution of the fumaric and maleic acids must be very different. Fumaric acid is the lower homologue of one of the three acids $C_5H_6O_4$, the formulæ of which must approximate very closely among themselves. The difference in this case is of quite another order from that between the formulæ of the fumaric and maleic acids.

Formation of Hydrates of Gases. — Bakhuis Roozeboom.—The author agrees with MM. de Forcrand and Villard on the interpretation of their results (*Comptes Rendus*, cvi., pp. 849 and 939), but he cannot consider the formation of the hydrates of gases in solutions is still unsolved.

The Slow Combustion of Certain Organic Matters. Th. Schlœsing.—The author concludes that, as it might be expected, the combustion of organic matter, *e.g.*, tobacco, accumulated in aërated masses, begins under the influence of living organisms. Between 40° and 50° this action ceases, and is succeeded by a purely chemical action, which is perceptible at 40°, and goes on increasing rapidly with the temperature.

Detection of Impurities in Alcohols.—X. Rocques.—The author compares the process of M. Savalle, which was indicated some years ago, with that proposed by M. Godefroy in *Comptes Rendus*, April 3rd, 1888. He concludes that pure benzene does not modify the Savalle test. Impure benzene (the so-called pure benzene of commerce) intensifies the reaction of the aldehyds. This fact would be of value if applied to the higher alcohols which we have no easy means of detecting. It is less interesting for the aldehyds which we can detect and even estimate by means of rosaniline bisulphite. In presence of aldehyds it is no more possible to distinguish the higher alcohols by the process of M. Godefroy than by that of Savalle. The aldehyds, by their intense colouration, mask the reaction of the alcohols. In the absence of aldehyds the process is not more sensitive than that of Savalle.

NOTES AND QUERIES.

Action of Light on Selenium.—Will any of your correspondents kindly give me particulars of the action of light on selenium, or inform me where I can obtain such information?—C. GRANVILLE WOOD.

MEETINGS FOR THE WEEK.

TUESDAY, 22nd.—Royal Medical and Chirurgical, 8.30.
— Royal Institution, 3. "Conventions and Conventionality in Art," by Sidney Colvin, M.A.
WEDNESDAY, 23rd.—Geological, 8.
— Society of Arts, 8.
THURSDAY, 24th.—Royal Institution, 3. "The Growth and Sculpture of the Alps," by Professor T. G. Bonney, D.Sc., LL.D., F.R.S., &c.
FRIDAY, 25th.—Quekett Club, 8.
— Royal Institution, 9. "Personal Identification and Description." by Francis Galton, M.A., F.R.S.
SATURDAY, 26th.—Royal Institution, 3. "The Later Works of Richard Wagner," by Carl Armbruster.
— Physical, 3. "Note on the Governing of Electromotors." by Prof. W. E. Ayrton, F.R.S., and Prof. J. Perry, F.R.S. "On the Formulæ of Bernouilli and Haecker for the Lifting Power of Magnets." by Prof. S. P. Thompson, D.Sc. "Experiments on Electrolysis. Part II. Irreciprocal Conduction," by Mr. W. W. Haldane Gee and Mr. H. Holden.

Just published. Demy 8vo., 1s., sewed (postage 2d.),
ASBESTOS: ITS PRODUCTION AND USE. With some Account of the Asbestos Mines of Canada. By ROBERT H. JONES.
London: CROSBY LOCKWOOD and SON, 7, Stationers' Hall Court, E.C.

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THE CHEMICAL NEWS.

Vol. LVII. No. 1487.

MAGNETIC QUALITIES OF NICKEL.*

By J. A. EWING, F.R.S., Professor of Engineering, University College, Dundee, and G. C. COWAN.

The experiments described in the paper were made with the view of extending to nickel the same lines of enquiry as had been pursued by one of the authors in regard to iron (*Phil. Trans.*, 1885, p. 523). Cyclic processes of magnetisation were studied, in which a magnetising force of about 100 c.g.s. units was applied, removed, reversed, again removed, and re-applied, for the purpose of determining the form of the magnetisation curve, the magnetic susceptibility, the ratio of residual to induced magnetism, and the energy dissipated in consequence of hysteresis in the relation of magnetic induction to magnetising force. Curves are given, to show the character of such cycles for nickel-wire in three conditions: the original hard-drawn state, annealed, and hardened by stretching after being annealed. The effects of these have also been examined, —(1) by loading and unloading magnetised nickel-wire with weights which produced cyclic variations of longitudinal pull, and (2) by magnetising while the wire was subjected to a steady pull of greater or less amount. The results confirm and extend Sir William Thomson's observation that longitudinal pull diminishes magnetism in nickel. This diminution is surprisingly great: it occurs with respect to the induced magnetism under both large and small magnetic forces, and also with respect to residual magnetism. The effects of stress are much less complex than in iron, and cyclic variations of stress are attended by much less hysteresis. Curves are given to show the induced and residual magnetism produced by various magnetic forces when the metal was maintained in one or other of certain assigned states of stress; also the variations of induced and residual magnetism which were caused by loading and unloading without alteration of the magnetic field. Values of the initial magnetic susceptibility, for very feeble magnetising forces, are stated, and are compared with the values determined by Lord Rayleigh for iron, and the relation of the initial susceptibility to the stress present is investigated. The paper consists mainly of diagrams in which the results are graphically exhibited by means of curves.

NOTE ON SOME CHINESE DYED SILKS.

By Dr. T. L. PHIPSON, F.C.S,
Member of the Society of Chemical Industry.

Many years ago I published some notes on the spectroscopic characters offered by various aniline dyes, and some colouring-matters of flowers (*Journal of the Chemical Society*, 1869, and *Journ. de la Soc. Roy. des Sciences Medicales et Naturelles, Bruxelles*, 1868). These observations convinced me that when the coal-tar colours were obtained we were, for the first time in Europe, put in possession of the very colours by which Nature adorns the flowers. In numerous cases besides those mentioned in the publications just referred to, I have found that the general chemical properties and spectroscopic characters of the flower-colours are identical with those of the coal-tar colours.

It may be remembered by some of my readers that just before the last named dyes came to light the chemical world was intensely interested in a new Chinese green called Lo Kao. It was a magnificent green on silk, and the first that did not appear blue at night. M. Persoz wrote a most interesting and extensive memoir upon it, in fact a considerable volume, with four pieces of dyed silk inserted into the work, as an illustration. I was fortunate enough to receive a copy of this valuable work from the author himself, whom I met in the Rue Bonaparte on the day of its publication.

The Chinese kept the preparation of the Lo Kao a complete secret; the French missionaries and others attempted in vain to discover the nature of it; experiments were made (on certain suggestions received from China) with plants of the genus *Rhamnus*, with the nettle, with certain kinds of berberry, &c., but all failed to produce a dye equal to the exquisite Chinese product, and many of the processes followed were, moreover, most expensive.

Whilst the excitement about the Lo Kao was still running high the accidental discovery of the aniline dyes came upon the scientific world like a clap of thunder, and soon everything connected with Lo Kao and other Chinese dyes was more or less forgotten. I shall never forget the words of Persoz on the day the news was received in Paris. Turning to me he said:—"C'est un de vos Anglais—et c'est simplement en oxydant l'aniline!"

A few years later I was commissioned to write a paper on the aniline dyes for a scientific periodical, which was illustrated with a considerable number of silk specimens, blue, mauve, red, yellow, &c., and a little later still I wrote my little prize essay:—"Sur les Propriétés Optiques, &c.," and a short supplement in the *Journal of the Chemical Society* (1869), comparing the spectra of certain flower-colours with those of the new aniline dyes.

In the course of another year or two I received from Singapore a small parcel of Chinese dyed silks (in skeins), which, when placed side by side with similar skeins produced in England and Germany from the coal-tar colours, it was impossible to distinguish one from the other: there was no mauve, but the blues, the yellows, and the pinks were absolutely similar to those of the magenta series; moreover, the spectroscopic characters of the solutions were also perfectly similar.

These particular specimens of Chinese silks had been dyed, as nearly as could be ascertained, some time previous to the year 1849, and, therefore, long before the coal-tar dyes were known. This circumstance also convinced me that the Chinese "chemists" had, at least in some instances, been *directly to the flowers* themselves for these magnificent colours; and there can be little doubt that there has existed in China, probably for a considerable number of centuries, a kind of practical chemistry, quite empiric (devoid of all theory?), which has produced results as astonishing as those produced centuries ago in physics and astronomy by the same ingenious people.

Dr. G. LUNGE'S IMPROVED NITROMETER.*

Former nitrometers, as well as Bunte's and Hempel's gas burettes, &c., have the following deficiencies.

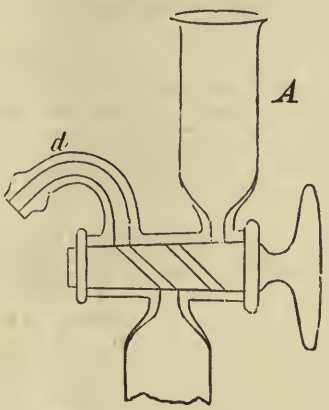
When using these apparatus it is necessary to pay great attention to the three-way stopcock, otherwise a slight overturning of the same will put the analysis in danger. This is to be avoided by using Greiner and Friedrich's new patent stopcocks with oblique borings. Prof. Lunge, the inventor of the nitrometer, recommends the patent stopcocks adapted to his apparatus, as will be seen in the accompanying sketches.

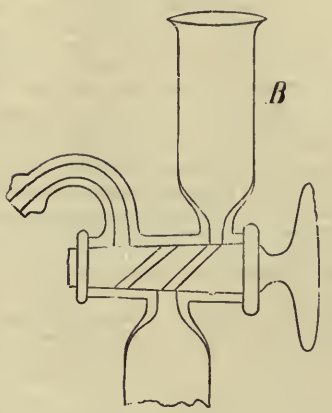
When using the nitrometer for the estimation of saltpetre, dynamite, &c. (whereby the chemical process

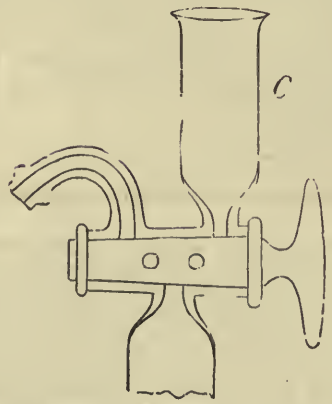
* Abstract of a Paper read before the Royal Society, May 18, 1888

* See *Berichte der Deutschen Chemischen Gesellschaft*, 1888 *Chemiker Zeitung*, &c.

takes place in the interior of the apparatus), the stopcock has to be turned like Fig. C, then put the chemicals into the funnel, open the stopcock (like B) and shut the same again (Fig. C). After having finished the analysis the stopcock must be turned to position A, and gas and acid can be removed through the bent tube, D.







This manipulation has the great advantage that the nitrous oxide leaving the bent tube will not be detrimental, while formerly the nitrous oxide and the acid has to be driven back into the funnel, where, exposed to the oxygen of the air, new compounds are created, which had to be removed by means of washing out with water.

When estimating peroxide of hydrogen, chamelion, chloride of lime, manganese, ammonia, urea, carbonic acid, &c., the small decomposing bottle is added to the bent tube, D, in the position A; after that the stopcock is turned for a moment into position B in order to put up the mercury or water to 0°, and turned back to A, after which the analysis can begin.

Another advantage of the improved nitrometer is that the stopper cannot be displaced during the shaking of the decomposing bottle as easily as formerly, as the above-mentioned bottle is independent of the stopper.

The nitrometers, as well as gas-burettes, and other apparatus with patent stopcocks, can be had in London in all sizes at Townson and Mercer's.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending April 30th, 1888.

By WILLIAM CROOKES, F.R.S.;
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To General A. De Courcy Scott, R.A.,
Water Examiner, Metropolis Water Act, 1871.

London, May 7th, 1888.

Sir,—We submit herewith the results of our analyses of the 168 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from April 1st to April 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The whole of the 168 samples examined were clear, bright, and well filtered.

The character of the Thames-derived water supplied to the metropolis, estimated alike by the proportion of organic matter present, the quantity of oxygen absorbable from permanganate, and the degree of colour-tint, has continued through the month of April to correspond very closely with that which prevailed in the preceding month of March. Thus the mean numbers expressing the organic carbon, the oxygen absorbed, and the degree of colour-tint for the month of March, being 0·162, 0·044, and 16·3 respectively, the corresponding numbers for the month of April were found to be 0·164, 0·047, and 15·9 respectively.

In the case of the East London Company's water derived from the Lea, the proportions of organic carbon and of oxygen absorbed, although almost identical with those met with in the water derived from the Thames, were found to be appreciably in excess of the proportions taken note of in last month's report; and a variation in the same direction, though to a smaller extent, was noticeable in the case of the New River Company's water, derived in part from the Lea, and in part from springs.

We are, Sir,
Your obedient Servants,
William Crookes.
William Odling.
C. Meymott Tidy.

RESEARCHES ON ALLOISOMERISM.*

I.

By ARTHUR MICHAEL.

(Continued from p. 196).

Behaviour of Aconitic Acid towards Aniline.

THE importance of the aniline reaction for ascertaining whether an unsaturated polybasic organic acid belongs to the maleic or fumaric acid series is shown when the classification of acids like aconitic, which decompose into simpler products on heating, is in question. That the method based on the formation of anhydrides cannot be used in such cases is obvious; but, as the following experiments indicate, the behaviour of an aqueous solution of the aniline salts of such acids is adapted to show to which series they belong.

An aqueous solution of dianiline aconitate, when boiled in a flask connected with a condenser, soon deposits an oily substance, mixed with some yellow needles. After the formation of the precipitate ceased to increase, it was separated from the mother-liquor and extracted with a little hot alcohol, which dissolved the amorphous substance. The residue was crystallised three times from alcohol.

0·1237 grm. substance gave 0·323 grm. CO_2 and 0·0545 grm. H_2O.

	Theory for $C_{18}H_{14}N_2O_3$.	Found.
C	70·59	71·13
H	4·57	4·91

The substance crystallises in very light yellow fine needles that melt at 250°—252°.† It is insoluble in water, sparingly soluble in hot alcohol. The very small yield of this substance obtained did not permit further examination. It may be identical with the anilide obtained by Pebal‡ by heating aniline aconitate to 140°, as its properties agree with those of the compound obtained by that chemist. The amorphous mass that is the principal product of the reaction could not be brought into a crystalline form. It is insoluble in dilute chlorhydric acid, and is possibly an anilide of the acid.

Far better results were obtained by allowing an aqueous solution of the dianiline salt to remain for some time at ordinary temperature. An amorphous substance also separates in this instance, but in equal quantities a crystalline substance. To separate them the precipitate was extracted with cold alcohol, when most of the amorphous substance went into solution. The residue was then crystallised four times from alcohol.

0 2102 grm. substance, dried at 100° C. in vacuum, gave 0·5134 grm. CO_2 and 0·1028 grm. H_2O.

0·3334 grm. substance, dried at 100° C. in vacuum, gave 23 c.c. N at 765·2 m.m. and 19° C.

	Theory for $C_{18}H_{16}O_4N_2$.	Found.
C	66 69	66 60
H	4·94	5·43
N	8 64	8·15

The substance crystallises in long prismatic needles that have a very faint pinkish cast and melt at 188°—189°. They are insoluble in hot water and dilute chlorhydric acid, but dissolve in alkalies; in hot alcohol they are pretty soluble, moderately in the cold solvent. Strong chlorhydric acid dissolves the substance in the cold, but the addition of water to the solution gives a precipitate of the original substance. The substance is formed from the dianiline salt by elimination of two molecules of water.§

It is evident from these results that aconitic acid elongs to the maleic and not to the fumaric acid series.* shall return to the importance of this conclusion in regard to the constitution of maleic acid in another paper.

Behaviour of Citra- and Itaconic Acids towards Secondary and Tertiary Aromatic Amines.

According to an observation made by Gottlieb,† an aqueous solution of monoethyl-aniline citraconate can be evaporated to dryness, and the residue heated to melting, without undergoing a change. It will be shown in the following paper that all primary aromatic amines having basic properties give anilides when aqueous solutions of their citraconic acid salts are heated, and it seemed of interest to examine secondary and tertiary aromatic amines in their behaviour towards the new reagent, as a convenient method of separation could probably be based on the results.

A solution of the acid, as well as the neutral, monoethyl-aniline citraconate can be gently warmed without any change, but on boiling the solution it will be noticed that the base is readily given off; in fact, a dilute aqueous solution of these salts when boiled to dryness is free of base, and the residue contains nothing but citraconic acid. The formation of an anilide, when the base was not allowed to escape, was never noticed, although the boiling was continued for a long time and very concentrated solutions were used. It was noticed, however, that solutions of the salts which were clear in the cold gave, on warming, a deposit of methyl aniline; a proof that the decomposition of the salts into base and acid takes place at the temperature of boiling water. Similar experiments were then made with monoethyl-aniline salts, and exactly the same results were obtained. A dilute aqueous solution of the salt when boiled down to dryness is free of base, and a solution made in the cold sets the base free when heated to 100°.‡

The dimethyl- and diethyl-aniline salts of citraconic acid are probably represented by the solutions obtained by saturating a strong aqueous solution of citraconic acid with the bases in the cold, but these compounds are so unstable that dilution suffices to decompose them into base and acid, and by heating the mixtures the base volatilises readily with the steam.

The ethyl derivatives of paratoluidine behaved exactly like the corresponding aniline compounds towards citraconic acid.

To a solution of 2·4 grms. of citraconic acid in 10 grms. of water, 3·4 grms. of diphenylamine were added, and the mixture was then boiled for an hour. On cooling the diphenylamine separated unchanged, and was completely soluble in dilute chlorhydric acid.

As itaconic acid forms only an acid anilide with aniline, it was thought possible that this acid might give an anilide with monomethyl and ethyl-aniline, but experiments showed that it acts exactly like citraconic acid toward these bases.

On these results a method of detecting and separating primary aromatic amines from secondary and tertiary amines was based. It is only necessary to dissolve the basic mixture in a solution of citraconic acid, then add an equal volume of citraconic acid to the solution, and boil in a flask with a reversed cooler for several hours. The flask is then connected with a condenser and the contents rapidly distilled almost to dryness, when, if oil-drops still

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* *American Chemical Journal*, Vol. ix., No. 3.

† In the preliminary note the melting-point of a less pure product was given at 215°—217°.

‡ *Annalen der Chemie*, xcviii., 81.

§ It would be premature to assign structural formulæ to these compounds, although it is very likely they stand in the relation of anilides to the acid. The formation of substances that are insoluble in dilute chlorhydric acid from aqueous solutions of the aniline salt is evidently sufficient to classify the acid as belonging to the maleic series. It is my intention, however, to have these compounds made the subject of a detailed examination.

* I have lately made some aconitic acid by heating the ether with strong chlorhydric acid in a sealed tube at 100°, when the pure acid separates on cooling. This product is quite insoluble in pure ether, while the acid obtained by heating citric acid is generally represented to be very soluble in that solvent. Is it possible that the first product represents the aconitic acid of the fumaric series? The subject deserves further investigation.

† *Annalen der Chemie*, lxxvii., 292.

‡ I am unable to explain the results obtained by Gottlieb with this salt, but suspect that he did not use pure ethylaniline, which, at the time of his experiments, was extremely difficult to obtain in a pure state.

go over towards the end of the operation, more water is added, and the operation repeated. The residue in the flask contains all the primary amines as anilides, and the bases may be obtained as chlorhydrates by decomposing the precipitate with strong chlorhydric acid. If the mixture contains secondary and tertiary amines which are not volatile with steam, the precipitate is treated with dilute chlorhydric acid, when they dissolve, leaving the anilide unchanged. It is not unlikely that the method may be used for a quantitative separation. For detecting a primary aromatic amine a small amount is treated as above in a test-tube, the solution boiled several minutes, replacing the water if necessary, and cooled. If a precipitate is formed that does not completely dissolve in dilute chlorhydric acid, the presence of a primary base may be considered as proved.*

Behaviour of Acetic and Succinic Acids towards Secondary and Tertiary Aromatic Bases.

The results obtained with citraconic acid were the reason for an examination of the behaviour of acetic and succinic acids, as types of fatty mono- and dibasic acids, towards aromatic bases.

Glacial acetic acid and aniline, in equivalent proportions, form, at ordinary temperature, a clear solution of aniline acetate. If this solution is kept under 30° it remains perfectly clear, but above that temperature it begins to become turbid, owing to the separation of minute oil-drops. It increases in turbidity up to 50°, above which temperature it gradually becomes less turbid, and finally perfectly clear at about 60°. On cooling the solution these phenomena are reversed. This remarkable behaviour is evidently due to the presence of a small amount of a base in so-called pure aniline, that has weaker basic properties than aniline itself. This view is corroborated by the following observation. If some water is added to aniline acetate the separation of a small amount of oil takes place, although the solution shows a strong acid reaction. The oil dissolves again when about three times as much water is added as the volume used of aniline acetate.†

An aqueous solution of aniline acetate, when boiled gradually, decomposes, and at first free aniline passes off; after this, a distillate that remains clear on cooling, which, as it contains both base and acid, evidently is aqueous aniline acetate; and finally acetic acid. I have tried a number of aniline salts of volatile fatty acids, and believe that the relation just described may be considered as a general one.

Mono- and dimethyl-aniline, and also the ethyl derivatives, dissolve in the equivalent amount of glacial acetic acid; but it is a matter of doubt whether it is more than simple solution, as the addition of water causes the base to separate. On the differences in their behaviour towards acetic acid a separation of primary amines from the secondary and tertiary bases was based. The basic mixture is dissolved in an excess of glacial acetic acid, three times the volume of water added, the mixture heated, and the oil separated from the solution of primary acetate. It is doubtful, however, whether this method is as exact as the one previously described.‡

Succinic acid (6 grms.) was dissolved in a small quantity of luke-warm water, and methylaniline (5 grms.) added On cooling, most of the base separated from the solution, which was filtered. The solution is clear at ordinary temperature, but becomes turbid, owing to the separation of an oil at about 30°. When boiled, methylaniline escapes leaving a solution of pure acid.

Behaviour of Citraconic Acid towards Fatty Amines.

That the formation of anilides from primary aromatic bases and citraconic acid stands in a close relation to the comparatively weak basic properties of the substances is shown by the behaviour of mono-, di-, and tri-ethylamine citraconates. The acid and neutral salts of these bases may be evaporated to dryness without undergoing any decomposition. A solution of amidoacetic acid in citraconic acid may be boiled without forming an anilide. On evaporating to dryness a residue soluble in water was obtained, but it is uncertain whether it was a citraconate or simply a mixture of the two substances. Aspartic acid does not combine with organic acids.*

(To be continued).

* It is evident that other unsaturated acids, as itaconic or phthalic acids, may be used. I have experimented with citraconic acid, as it seemed best adapted for the purpose, and can be made in large quantities without trouble. It is also apparent that the reaction may be used for detecting acids belonging to the maleic acid series, and in some instances to separate them from other organic acids. With acids like citra-, itaconic, and phthalic, the separation is almost quantitative. There is no doubt that the reaction will prove of considerable use, not only in the investigation of basic aromatic mixtures, but also in studying the decomposition products of organic polybasic acids.

† It is doubtful whether perfectly pure aniline has ever been made. The oil may be amidothiophene, and its investigation is certainly of interest. I shall attempt to obtain it in sufficient amount to ascertain its nature.

‡ Thia method can of course only be used to separate those primary aromatic amines that form salts with acetic acid.

* The best method of making aspartic acid from asparagine is to boil that substance with alkalies until ammonia ceases to come off, and then acidulate with acetic acid, when all the aspartic acid is precipitated.

† From the *Journal of the Chemical Society* for May, 1888.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Anniversary Meeting, March 28th, 1888.

Address of the President, William Crookes, F.R.S.†

(Continued from p. 199).

Elements and Meta-Elements.

Permit me, gentlemen, now to draw your attention for a short time to a subject which concerns the fundamental principles of chemistry, a subject which may lead us to admit the possible existence of bodies which, though neither compounds nor mixtures, are not elements in the strictest sense of the word;—bodies which I venture to call "meta-elements."

To explain my meaning it is necessary for me to revert to our conception of an element. What is the criterion of an element? Where are we to draw the line between distinct existence and identity? No one doubts that oxygen, sodium, chlorine, sulphur, are separate elements; and when we come to such groups as chlorine, bromine, iodine, &c, we still feel no doubt, although were degrees of "elementicity" admissible—and to that we may ultimately have to come—it might be allowed that chlorine approximates much more closely to bromine than to oxygen, sodium, or sulphur.

Again, nickel and cobalt are near to each other, very near, though no one questions their claim to rank as distinct elements. Still I cannot help asking what would have been the prevalent opinion among chemists had the respective solutions of these bodies and their compounds presented identical colours, instead of colours which, approximately speaking, are mutually complementary? Would their distinct nature have even now been recognised?

When we pass further and come to the so-called rare earths the ground is less secure under our feet. Perhaps we may admit scandium, ytterbium, and others of the like sort to elemental rank; but what are we to say in the case of praseo- and neo-dymium, between which there may be said to exist no well-marked chemical difference, their chief claim to separate individuality being slight differences in basicity and crystallising powers, though their physical distinctions as shown by spectrum observations are very strongly marked? Even here we may imagine the disposition of the majority of chemists would

incline towards the side of leniency, so that they would admit these two bodies within the charmed circle. Whether in so doing they would be able to appeal to any broad principle is an open question.

If we admit these candidates, how in justice are we to exclude the series of elemental bodies or meta-elements made known to us by Krüss and Nilson? Here the spectral differences are well marked, whilst my own researches on didymium show also a slight difference in basicity between some at least of these doubtful bodies. In the same category must be included the numerous separate bodies into which it is probable that yttrium, erbium, samarium, and other "elements"—commonly so-called—have been and are being split up. Where then are we to draw the line? The different groupings shade off so imperceptibly the one into the other that it is impossible to erect a definite boundary between any two adjacent bodies and to say that the body on this side of the line is an element, whilst the one on the other side is non-elementary, or merely something which simulates or approximates to an element. Wherever an apparently reasonable line might be drawn it would no doubt be easy at once to assign most bodies to their proper side, as in all cases of classification the real difficulty comes in when the border-line is approached. Slight chemical differences of course are admitted, and, up to a certain point, so are well-marked physical differences. What are we to say, however, when the only chemical difference is an almost imperceptible tendency for the one body—of a couple or of a group—to precipitate before the other? Again, there are cases where the chemical differences reach the vanishing point, although well-marked physical differences still remain. Here we stumble on a new difficulty: in such obscurities what is chemical and what is physical? Are we not entitled to call a slight tendency of a nascent amorphous precipitate to fall down in advance of another a "physical difference?" And may we not call coloured reactions depending on the amount of some particular acid present, and varying according to the concentration of the solution and to the solvent employed, "chemical differences?" I do not see how we can deny elementary character to a body which differs from another by well-marked colour- or spectrum-reactions, whilst we accord it to another body whose only claim is a very minute difference in basic powers.

Having once opened the door wide enough to admit some spectrum differences, we have now to enquire how minute a difference qualifies the candidate to pass? I will give instances from my own experience of some of these doubtful candidates.

1. Two closely allied bodies* differ slightly in basic powers and more decidedly also in their spectrum reactions; are they distinct entities? Probably yes.

2. Two bodies† have no distinct spectrum reaction, and differ in basicity so slightly that their separation has hitherto proved to be impossible; but they differ decidedly in the colour of their oxides. Are they different? I should in this case also say "yes."

3. Two bodies‡ obtained from different minerals have no recognisable chemical difference, but there is a strong line in the phosphorescent spectrum of one which is absent in the other. What are we to say in this case?

4. An earth§ separated with enormous difficulty from its associates has a certain very definite phosphorescent spectrum. The addition of another body greatly intensifies one or more of the lines of the spectrum of the earth so separated, while upon the other lines in the spectrum of the same earth it has no action. Is the basis of this earth simple or compound?

5. An earth* showing no difference on fractionation has a phosphorescent spectrum not materially modified by the admixture of another earth; but the residual glow of one part of the spectrum as seen in the phosphoroscope is suppressed, while that of the other is not affected. Are we not here also dealing with more than one sort of molecule?

6. Earths,† apparently the same, from different minerals, behave alike chemically and spectroscopically, with the exception that a certain line in the spectrum of the one is a little brighter than the corresponding line in the spectrum of the other.

Again, where are we to draw the line? If an immediate decision were required, and a poll of the chemists in this room demanded, we should probably find the dividing lines placed in all positions among these seven cases.

But to have only one rank in the elementary hierarchy, to class these obscure and indefinite bodies in the same rank with silver and chlorine and oxygen and sulphur, is as manifest an absurdity as it would be to put a speck of meteoric dust upon a level with the planet Jupiter because both may be called distinct members of the solar system.

Is there no way out of this perplexity? Must we either make the elementary examination so stiff that only some 60 or 70 candidates can pass, or must we open the examination doors so wide that the number of admissions is limited only by the number of applicants?

The real difficulty we encounter by unlimited multiplication of elements arises from the Periodic theory. That theory has received such abundant verification that we cannot lightly accept any interpretation of phenomena which fails to be in accordance with it. But if we suppose the elements reinforced by a vast number of bodies slightly differing from each other in their properties, and forming, if I may use the expression, aggregations of nebulæ where we formerly saw, or believed we saw, separate stars, the periodic arrangement can no longer be definitely grasped. No longer, that is, if we retain our usual conception of an element. Let us then modify this conception. For "element" read "elementary group," such elementary groups taking the place of the old elements in the periodic scheme,—and the difficulty falls away.

In defining an element, let us not take an external boundary, but an internal type. Let us say, *e.g.*, the smallest ponderable quantity of yttrium is an assemblage of ultimate atoms almost infinitely more like each other than they are to the atoms of any other approximating element. It does not necessarily follow that the atoms shall all be absolutely alike among themselves. The atomic weight which we ascribe to yttrium, therefore, merely represents a mean value around which the actual weights of the individual atoms of the "element" range within certain limits. But if my conjecture is tenable, could we separate atom from atom, we should find them varying within narrow limits on each side of the mean.

The very process of fractionation implies the existence of such differences in certain bodies. Until lately such bodies passed muster as elements. They had definite properties, chemical and physical; they had recognised atomic weights. If we take a pure dilute solution of such a body, yttrium for instance, and if we add to it an excess of strong ammonia, we obtain a precipitate which appears perfectly homogeneous. But if instead we add very dilute ammonia in quantity sufficient only to precipitate one half of the base present, we obtain no immediate precipi-

* Erbium and holmium; erbium and yttrium; samarium and didymium, &c.

† The white and yellow components of cerium (*Phil. Trans.*, clxxi. (1885), 704.

‡ Yttrium from samarskite gives the Sδ line, whilst in that from gadolinite this line is absent (*Proc. Roy. Soc.*, xl. (1886), 502—509). The reputed Yα of M. de Marignac contains all the phosphorescent lines of the old yttrium spectrum except the line of Gδ (*Proc. Roy. Soc.*, xl. (1886), 236).

§ The phosphorescent spectra of yttrium and samarium are modified by the addition of various earths in the way here mentioned. Samarium affects the alumina spectrum in a similar manner (*Proc. Roy. Soc.*, xlii. (1887), 111—131).

* Calcium sulphate and many other bodies behave in this manner in the phosphoroscope (*Proc. Roy. Soc.*, xlii. (1887), 120).

† Yttrium from different minerals shows great variations of intensities in all its lines. Gζ appears in greater quantity in samarskite than it does in gadolinite (Chemical News, liv. (1886), 157).

ate. If we stir up the whole thoroughly so as to ensure a uniform mixture of the solution and the ammonia, and set the vessel aside for an hour, carefully excluding dust, we may still find the liquid clear and bright without any vestige of turbidity. After three or four hours, however, an opalescence will declare itself, and the next morning a precipitate will have appeared.

Now, let us ask ourselves what can be the meaning of this phenomenon?

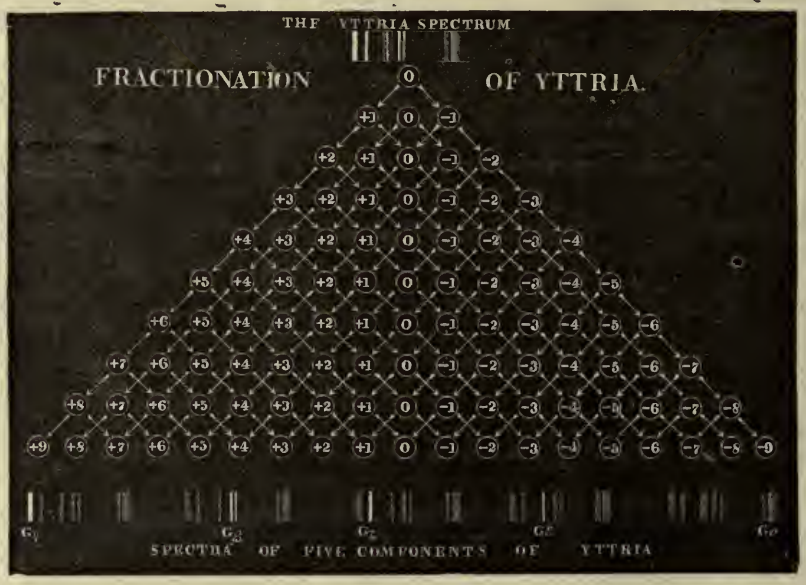
The quantity of precipitant added was insufficient to throw down more than half the yttria present, therefore a process akin to selection has been going on for several hours. The precipitation has evidently not been effected at random, those molecules of the base being decomposed which happened to come in contact with a corresponding molecule of ammonia, for we have taken care that the liquids should be uniformly mixed, so that one molecule of the original salt would not be more exposed to decomposition than any other. If, further, we consider the time which elapses before the appearance of a precipitate, we cannot avoid coming to the conclusion that the action which has been going on for the first few hours is of a *selective* character. The problem is not *why* a precipitate is produced, but *what determines* or directs some atoms to fall down and others to remain in solution. Out of the multitude of atoms present, what power is it that directs each atom to choose the proper path? We may picture to ourselves some directive force passing the atoms one by one in review, selecting one for precipitation and another for solution, till all have been adjusted. In order that such a selection can be effected there evidently must be some slight differences between which it is possible to select, and this difference almost certainly must be one of basicity, so slight as to be imperceptible by any test at present known, but susceptible of being nursed and encouraged to a point when the difference can be appreciated by ordinary tests.

Let us follow our atoms through another stage of fractionation. The ammonia has divided them into two groups, one of which displays just the minutest possible suspicion of greater basicity than the other. Let us repeat the first experiment again with these two groups. Again, we obtain from each a precipitate and a solution, so that we have now two precipitates and two solutions. It is evident that whereas the precipitate from the original salt was slightly less basic than that which remained dissolved, the second precipitate from the first precipitate must have its basic character still further diminished, while at the same time the second solution from the first solution must contain selected atoms of a slightly higher degree o basicity. The least basic at one end and the most basic at the other end are thus two removes each from the original; and treating them in the same way for a third time, we obtain two groups of atoms which are three removes from the centre. (The intermediate groups need not be here discussed. By systematic mixings they can be made to contribute their quota to the end groups.) By repeating this operation, not once or twice but many hundreds of times, those atoms having a tendency to come down first always going one way, and those having a tendency to remain dissolved always going the other way, we, so to speak, *educate* the atoms, adding to them no fresh properties, but drawing out and giving free scope to properties that already existed, but that were previously masked.

A similar absence of absolute homogeneity may possibly yet be traced in many of the "elements" if once the right reagents are selected, and if laborious chemists are to be found willing to devote years to researches barren to outward seeming.

That this deviation from absolute homogeneity should mark the constitution of these molecules* or aggregations of matter which we designate elements will perhaps be clearer if we return in imagination to the earliest dawn of our material universe, and face to face with the great secret, try to consider the processes of elemental evolution.

Fig. 1.



Going back to the "fire-mist," the "ur-stoff" of the German philosophers, or the "protyle," as, after Roger Bacon, I have ventured to call it, we see an infinite number of immeasurably small ultimate, or rather ultimatissimate particles gradually accreting out of "formless stuff," and moving with inconceivable velocity in all directions. We find those particles which approximately have the same rate and modes of movement, beginning to heap themselves together by virtue of that ill-understood tendency through which like and like come together—

Clerk-Maxwell defines a molecule as "a material system, the parts of which are connected in some definite way. ("Atom," *Encyclopædia Britannica*, 9th Ed., 3, 43.

that principle by virtue of which identical or approximately identical bodies are found collected in masses in the earth's crust instead of being uniformly distributed.

One of the first results of this massing tendency is the formation of certain nodal points in space, between which occur approximately void intervals. How such nodes and spaces come to be formed we shall be better able to understand by a very few simple illustrations, choosing in the first instance, instead of ultimate atoms, living men and women.

If we take any very frequented street in London, say Fleet Street, at a time when the animated current runs pretty equally in two directions, and if our rate of walking is somewhat greater than the mean speed of the other foot-passengers, we shall observe that the throngs on the footways are not evenly distributed, but consi t of knots or groups—we might almost say blocks—with comparatively open intervening spaces. The explanation of this unequal agglomeration of individuals is simple. Some two or three persons whose rate of walking is slower than the average somewhat retard the movements of other persons, whether travelling in the same or in the opposite direction. In this manner a slight temporary obstruction is created. The persons behind catch up to the obstruction, and so increase it, while those in front of the obstruction, hurrying on unhindered at their former rate, leave a comparatively free and open space, until they, too, find themselves delayed further on by another little group of loiterers.

The same process may be observed with vehicles in the carriage-way of much frequented streets. Thus we find that differences in rate of movement are sufficient to arrange a multitude of moving bodies into a series of knots and gaps.

In a crowded thoroughfare like Fleet Street, with two opposing human currents, much regularity in the sequence of these knots and voids is not to be expected; but if the observer happens to be walking with a crowd whose constituents are travelling in the same direction, the regularity becomes more apparent; and if, as is sometimes the case, a little rhythm is infused into the steps by an accompaniment of music, the knots and gaps become so orderly that the distance between one block and another, measured in yards, will be found not to differ very greatly from one end of the road to the other.

If, instead of men and women, we experiment with little grains of substances of approximately equal size, but differing in specific gravity, and, mixing them in a horizontal tube, with water, we set them in movement by rhythmical agitation, similar phenomena will occur, and the heavy and light powders will sort themselves in a very regular manner.* Descending to a lower degree of minuteness, we all know what occurs when an induction current is passed through a rarefied gas. Here the particles being exempt from free will or caprice, implicitly obey the law I have attempted to illustrate, and out of infinite disorder, under the influence of the electric rhythm, sort themselves into beautiful forms of stratifications.

(To be continued.)

PHYSICAL SOCIETY.

May 12th, 1888.

Professor Reinold, F.R.S., President, in the Chair.

Mr. G. L. Addenbrooke and Mr. H. A. Cunyghame were elected members of the Society.

The following papers were then read:—

"*Note on the Condition of Self-excitation in a Dynamo Machine.*" By Prof. S. P. Thompson, D.Sc.

It is a well-known fact that a series dynamo running at a given speed will not excite itself unless the resistance is less than a certain value, depending on the speed and construction of the machine, and if the resistance is slightly less than this critical value the excitation will not be such as to saturate the magnets. According to the primitive statement of the action of self-exciting dynamos on the "compound interest law" a dynamo should excite itself to saturation at any finite speed, providing the resistance is not infinite. An explanation of the observed facts is given in the paper without any assumption as to the curve of magnetisation. If E = E.M.F. of the machine, n = speed, C = number of wires on outside of armature, N = number of magnetic lines, i = current, S = number of turns on magnet, ΣR and $\Sigma\varsigma$ the sums of the electric and magnetic resistances respectively; then $E = n\mathrm{CN}$, $i = n\mathrm{CN}/\Sigma R$, and $N = 4\pi Si/\Sigma\varsigma$. From these it is easily seen that $4\pi n\mathrm{CS} = \Sigma\varsigma.\Sigma R$, (A), *i.e.*, for a dynamo running at constant speed the product of the magnetic and electric resistances is constant, and the dynamo will not excite itself if ΣR is greater than $4\pi n\mathrm{CS}/\Sigma\varsigma$. Similarly for a given value of ΣR, excitation is impossible if n is less than $\Sigma\varsigma.\Sigma R/4\pi\mathrm{CS}$. For a value of ΣR less than the critical value the excitation increases until the magnetic restance is increased so that equation (A) is satisfied. The corresponding value for shunt machines is—

$$4\pi n\mathrm{CZ} = \Sigma\varsigma\left\{(r_a + r_s) + \frac{r_a + r_s}{\mathrm{R}}\right\}$$

where Z = number of shunt turns, r_a, r_s, and R the resistances of armature, shunt and external circuits respectively.

In the discussion which followed Mr. Kapp described a method used in testing dynamos, for determining the minimum speed at which dynamos will excite themselves, and from thence determining the magnetic resistance of the air gap. In all cases experiment showed this to be less than the calculated resistance, generally in the proportion of 1500 to 1860, the difference being greater in low tension machines.

Prof. Ayrton pointed out that permanent magnetism was not taken into account, and that the apparent resistances due to self-induction, and between the brushes and commutator, were considerable for small currents.

Lord Rayleigh said Sir W. Thomson had shown critical speeds for given resistances to exist in Faraday's disc dynamo. He (Lord Rayleigh) did not approve of the term "magnetic resistance," and thought "reluctance," as recently suggested by Mr. Heaviside, would be preferable.

"*Note on the Conditions of Self-regulation in a Constant Potential Dynamo Machine.*" By the same author.

In "Dynamo Electric Machinery," a formula—

$$\frac{Z}{S} = \frac{r_s}{r_a + r_m}$$

is given as expressing the ratio of the numbers of turns in the shunt and series windings of a compound dynamo. This is on the assumption that there is no saturation within the working limits. As this assumption is not legitimate, a correcting factor is necessary. The factor is shown to be the ratio of the average permeability over the whole working range, to the permeability corresponding with no external current. The formula is transformed so as to be expressed in terms of the "satural" data of the machine, which, as shown in a previous paper can be calculated from its details.

"*On Magnetic Lag and the Work lost due to Magnetic Lag in Alternating Current Transformers.*" By Mr Thomas H. Blakesley, M.A.

* "The atoms run like to like, as you may see either in the case of seeds which are being winnowed in a sieve, or in the case of pebbles on the sea shore; for on account of the whirling of the sieve beans are separated and go with beans, barley with barley, and wheat with wheat; and on account of the motion of the waves, the longish pebbles are driven to the same spot as the longish ones, and the round with the round." Democritus, in a fragment given in *Sextus Math.* (vii., 116 seq.). "The Atomic Theory of Lucretius," by John Masson. 1884, p. 66.

The method adopted to detect the lag is to place dynamometers in both circuits, and one with a coil in each. Then, on the supposition that the E.M.F. of the secondary circuit is entirely due to the changing magnetism of the core, the author proves that the tangent of the magnetic lag angle must be equal to—

$$\frac{\frac{m}{n} C\alpha_3 - B\alpha_2}{\frac{m}{n} \sqrt{(AB\alpha_1\alpha_2 - C^2\alpha_3^2)}}$$

where m and n are the numbers of turns in the primary and secondary coils respectively, A B C the constants of the dynamometers, and α_1 α_2 α_3 their angular reading. A is such that—

$$A\alpha_1 = \frac{I_1^2}{2}$$

where I is the maximum value of the primary current. A table of actual results is given, where the magnetic lag is about $5\frac{1}{4}°$. The whole power given out by the machine takes the form—

$$r_1 A\alpha_1 + r_2 \frac{m}{n} C\alpha_3$$

where r_1 and r_2 are the resistances of the primary and secondary circuits, while the power lost in hysteresis is expressed by—

$$r_2\left(\frac{m}{n} C\alpha_3 - B\alpha_2\right).$$

The lag is attributed to an induced magnetic stress called into being by the increasing or decreasing magnetism itself, and always opposing it, as motion in a medium induces an opposing force of friction. By supposing such an induced magnetic stress in quadrature (as Mr. Blakesley expresses it) with the magnetism, and of such a value as, when compounded with the stresses due to the currents, shall bring the resultant into quadrature with the secondary current, the effective magnetic stress is obtained. This involves a new idea called Magnetic Self-Induction, with its coefficient. The whole problem is treated by the geometrical method, which the author has applied to several other problems in alternating currents.

Mr. Kapp, Profs. Thompson, Perry, and Ayrton, and Lord Rayleigh took part in discussing the paper.

"*On a Simple Apparatus for the Measurement of the Coefficient of Expansion by Heat.*" By Prof. W. E. Ayrton and Prof. J. Perry, F.R.S.

The apparatus consists of a metal tube within which the wire or rod whose coefficient is to be determined is placed. One end of the wire is rigidly attached to one end of the tube, and the other end connected to an Ayrton and Perry magnifying spring, a pointer attached to which indicates the change of length due to alteration in temperature. Steam or water may be passed through the tube, the temperature of the wire being shown on a thermometer. The arrangement is very sensitive, and with a pointer about 20 c.m. long, the motion is magnified about 1000 times.

A magnifying spring attached to an aneroid was also shown, and its great sensibility demonstrated. A combination of a spring of large diameter and pitch with one of small diameter and pitch was exhibited. By such a combination small rotations can be immensely magnified. The great features of the patent spring as a magnifier are the entire absence of friction and back lash, and the large range of proportionality.

A note on the "*Governors of Electromotors*," by the authors, and one the "*Electrical Action of Light*," by Mrs. W. E. Ayrton, were postponed until next meeting.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, May 7, 1888.

Sir James Crichton Browne, M.D., LL.D., F.R.S., Vice-President, in the Chair.

The following Vice-Presidents for the ensuing year were announced:—

Sir James Crichton Browne, M.D., LL.D., F.R.S.; William Crookes, F.R.S.; Warren de la Rue, M.A., D.C.L., F.R.S.; Colonel James A. Grant, C.B., C.S.I., F.R.S.; Sir Frederick Pollock, Bart., M.A.; John Rae, M.D., LL.D., F.R.S.; Henry Pollock, Treasurer; Sir Frederick Bramwell, D.C.L., F.R.S., Honorary Secretary.

John Hutton Balfour-Browne, Q.C., Lady Roscoe, John Callander Ross, and T. E. Thorpe, Ph.D., F.R.S., were elected Members of the Royal Institution.

Six Candidates for Membership were proposed for election.

John Tyndall, D.C.L., LL.D., F.R.S., was elected Honorary Professor of Natural Philosophy.

The Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., was elected Professor of Natural Philosophy.

The presents received since the last meeting were laid on the table, and the thanks of the Members returned for the same.

NOTICES OF BOOKS.

Sell's Dictionary of the World's Press and Advertising Reference Book. 1888. By Henry Sell. London: Sell's Advertising Agency, Limited.

A work of this kind is a great convenience, if not a necessity, to numbers of persons in addition to advertisers, and it must be recognised that Mr. Sell has in all probability approached nearer to the ideal of such a compilation than any of his predecessors. In addition to the mere directory of newspapers and journals there is much useful matter. Thus we find almost at the outset a summary of the law of libel, which certainly requires cutting down a good many stages before it can be admitted as satisfactory. At present even the proprietors and conductors of scientific and technical journals, who do not at all concern themselves with personal matters, can never absolutely know when they are safe from litigation and annoyance. Next follow the stipulations of the International Convention on copyright,—an agreement sadly crippled, as far as Britain is concerned, by the non-accession of the United States.

The chapters on the "Rise of Provincial Journalism" and "Notable Press Prosecutions" are too pointedly political to admit of our notice.

The question of "Anonymous Journalism *v.* Personal Journalism" is discussed at some length. Of course in scientific periodicals, where observations and experiments are concerned, the signature of the writer is essential; but wherever the facts are already before the public, as in the discussion of theories and the review of works, anonymous writing has our preference. Where articles in magazines and journals are signed, the public ask not what is said, but who said it, and are apt to ignore the ablest matter from the pen of an unknown writer.

Passing to the Directory itself we must, of course, judge it from the point of view of scientific and technical journalism. This seems to be the least successful department of the "Dictionary." We find some publications of this class wanting which we know to be in existence, whilst at least one is mentioned which has ceased to appear for a couple of years.

If we examine the lists of Continental publications we find a much greater deficiency in the same sphere. Not one of the French scientific journals—some of which are very important—is mentioned. The same is the case

with the German and Italian journals of this class. Hence we must regard the "Dictionary of the World's Press," though undoubtedly useful, as capable of very great improvement.

CORRESPONDENCE.

PRESSURE TUBES.

To the Editor of the Chemical News.

Sir,—Having noticed Mr. H. N. Warren's note entitled "Pressure Tubes, their Use and Construction" (Chemical News, vol. lvii., p. 155), and having lately required a similar tube, I substituted for the magnesia fine iron filings, and with considerable advantage, these being a much better conductor of heat. It may, however, be only just to mention that the tubes prepared according to Mr. Warren's construction will stand an enormous pressure, and it is evident that if Mr. Warren continues his important researches we shall undoubtedly, before long, be in possession of a new chemistry.—I am, &c.,

L. R.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of emperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 19, May 7, 1888.

The Acid Phosphites of the Alkaline Metals.—L. Amat.—In a former memoir the author proved the existence of an acid ammonium phosphite. He has now succeeded in preparing the corresponding potassium and sodium salts.

Properties of Sodium Disulpho-persulphate.—A. Villiers.—This salt, when anhydrous, crystallises in orthorhombic prisms. The anhydrous salt is permanent in the air; it fuses at about 125°, and at 140° it swells up, giving off sulphurous acid. The residue is potassium sulphate and sulphur, not accompanied by a sulphide. Its solutions, when mixed with metallic solutions, do not yield precipitates, except with mercuric chloride.

The Crystalline Form of Sodium Trithionate.—A. Villiers.—It crystallises with 3 mols. of water, forming orthorhombic prisms, the measurements of which are given by the author.

On Hydrated Methyl Chloride.—MM. de Forcrand and Villard.—The authors examine and measure the tension of dissociation of this compound. Their results at low and high pressures are given in the form of tables.

On Terpinol.—G. Bouchardat and R. Voiry.—The complex product of the action of alcoholic potassa upon terpilene dihydrochlorate, though in some respects presenting analogies with List's terpinol is essentially distinct. It contains compounds of different chemical functions, but all belonging to the series of terpilene, which is the only definite compound common to the two products.

Moniteur Scientifique, Quesneville.
Series 4, Vol. ii., February, 1888.

Detection of Cotton Oil in Olive Oil.—Ernest Milliau.—In a porcelain capsule, holding about 1 litre, 15 c.c. of the oil in question are heated to 110°. Then, whilst still continuing to heat, we pour upon the oil a mixture of 15 c.c. of a solution of soda at 40° Baumé in distilled water and of 15 c.c. of alcohol at 92 per cent. When the mass has become homogeneous we add, drop by drop, so as not to cool the paste and form clots, about ½ litre of distilled water. After boiling for a few minutes we separate the fatty acids by means of pure sulphuric acid diluted to one-tenth. As soon as the separation is complete and the sulphuric acid is in slight excess, 5 c.c. of the hydrated fatty acids are collected with a silver spoon and poured at once into a test-tube, about 3 c.m. in diameter and 12 in length. We add 20 c.c. of alcohol at 92° per cent, and heat slightly in the water-bath to dissolve the fatty acids. When the solution is effected, 2 c.c. of a solution of silver nitrate (30 grms. in 100 c.c. of distilled water) are added, the tube is placed in the water-bath and heated until about one-third of the mass is evaporated. The tube is then removed from the water-bath. Whatever is the origin of the olive-oil, its fatty acids remain unaltered if the oil is pure. But if cotton oil is present the silver is reduced, and blackens the fatty acids which rise to the surface. In this manner 1 per cent of cotton oil can be detected in olive oil.

Revue Universelle des Mines et de la Metallurgie.
Series 3, Vol. i., No. 2, February, 1888.

This issue contains no original chemical matter.

Zeitschrift fur Analytische Chemie.
Vol. xxvi., Part 5.

Contributions to the Methods of Examining Cod Liver Oil and Vegetable Oils.—Prof. E. Salkowski.—This bulky memoir is not capable of useful abstraction. The author's object is the detection of vegetable oils in animal fats, and especially in cod-liver oil.

Determination of Phosphoric Acid.—A. Isbert and A. Stutzer.—The authors wash the molybdic precipitate, not with ammonium nitrate or molybdate, but with cold water, and thus dissolve the ammonium phospho-molybdate. Five grms. of the substance under examination are heated in a half-litre flask with hydrochloric acid or aqua regia; when cold filled up at once to the mark with water, shaken up, filtered, 50 c.c. of the filtrate are mixed with an excess of ammonia, acidulated with nitric acid, and the phosphoric acid is precipitated with ammonium molybdate. The yellow precipitate, after it has completely settled (at 60° to 70°) is let cool and filtered at once, the supernatant liquid being first passed through the filter, the precipitate repeatedly washed by decantation, placed upon the filter, and repeatedly washed with water. The total volume of the washing water is about ¼ litre. The phosphoric acid is then volumetrically determined by the distillation method. Where an error of 0·1 per cent is the utmost limit the gravimetric method must be retained. The uranium titration process is not admissible.

Ultimate Analysis of Volatile Carbon Compounds.—Dr. G. Kassner.—This paper requires the accompanying figure.

On the Determination of Nitrogen by Kjeldahl's Process.—L. Lenz.—Where an accurate determination of nitrogen is required potassium permanganate should be used for oxidising the substance which has been boiled with suphuric acid.

The Sanitary Analysis of Air.—Klas Soudén.—The author's process cannot be made intelligible without the cut representing the apparatus.

Quantitative Determination of Antimony, founded upon the Ready Solubility of Hydrated Antimony Sulphide in Ammonium Polysulphide.—Dr. F. Muck.—The precipitate of sulphide, obtained in the ordinary manner and washed out, is dried until it begins to split off from the paper in curved fragments. These are removed from the filter as far as practicable by means of a

spatula and laid aside upon a glass plate. The funnel is placed over a capsule and the remainder of the precipitate is dissolved of from the filter by dropping upon it warm ammonium sulphide containing much free sulphur in solution. A very small quantity of this solvent suffices if the filtrate is poured back upon the filter. The filter is finally washed with ammonia, to which a little ammonium sulphide is added, the liquid is placed in a tared porcelain capsule, which is set under the exsiccator over sulphuric acid until most of the ammonia has escaped, and it is finally evaporated on the water-bath, adding the washings, and the main portion of the precipitate which had been set aside. The sulphide is converted into the so-called antimony antimoniate by Bunsen's process, and the sulphur is expelled as follows:—A few c.c. of carbon disulphide are poured into the crucible, stirred with a glass rod, chloroform is added, and the vessel is set for a few minutes upon a water-bath, slightly heated. The crucible is covered with a watch-glass, which is kept charged with cold water, constantly renewed. After allowing the mixture to settle for a few moments, the crucible is set in a flat-bottomed porcelain capsule, brought into a sloping position, and the liquid decanted. This digestion on the water-bath and decantation are repeated several times, rinsing the outside of the crucible each time with the solvent. The particles which have passed into the flat-bottomed capsule deposit and collect easily, and may be returned to the crucible, the contents of which are converted into antimony antimoniate and weighed.

Simple Apparatus for Evaporating Ammoniacal Liquids at Low Temperatures.—Dr. F. Muck.—The apparatus is essentially an exsiccator admitting of the application of heat, and thus serving instead of the air-pump.

Iodide Coatings before the Blowpipe. — Wheeler and Ludeking.—The author's results are given in the *Transactions of the St. Louis Academy of Science* (vol. iv., No. 4).

Indirect Determination of Alkalies, especially in Presence of Lithia.—K. Kraut.—The alkalies are converted into nitrates, weighed as such, and the proportion of nitric acid is determined by ignition with silica. Alkaline chlorides are converted into nitrates by precipitating the solution with silver nitrate, filtering, and removing silver by treatment with hydrocyanic acid (free from sulphuric acid). If phosphates are present they are dissolved in water, or in case of lithia in a minimum of nitric acid, a quantity of silver nitrate equivalent to the phosphoric acid is added, and the liquid is neutralised with moist silver oxide, freshly precipitated. When all the phosphoric acid is precipitated the excess of silver is removed by treatment with hydrocyanic acid. This method is not applicable if alkaline sulphates are present.

Detection of Nitric Acid in Well-waters. — Otto Binder.—The author adds to 30 c.c. of water a very small quantity of zinc powder and shakes well. He then adds a few drops of dilute sulphuric acid and shakes well. On adding iodised starch paste the reaction instantly appears.

Water Analysis.—Otto Binder.—In evaporating water it is necessary, in order to prevent the absorption of sulphur compounds, to place beneath the capsule a broad plate of iron or earthenware, or to evaporate in the water-bath.

Determination of Nitric Acid.—Dr. Kratschmer.—This process cannot be intelligibly summarised without the accompanying figure.

Analyses of Pure Alsace-Lorraine Wines, of the Season 1885.—Carl Amthor.—A paper of little interest.

Modifications in Gas lamps and Gas-cocks.—Hugo Schiff.—Unintelligible without the three accompanying figures.

Relative Permeability of Different Diaphragms for Dialysis.—A. Zott.—No particulars given.

Stand for Drying Precipitates in the Funnel.—V. Meurer.—This paper requires the accompanying illustration.

Tension of Mercury Vapour at Low Temperatures. — J. D. van der Plaats.—From the *Journal of the Chemical Society*.

Escape of Dissolved Solids during Evaporation of the Solvent.—P. Marguerite-Delacharlonny.—From the *Comptes Rendus*.

Determination of Ash by Means of Leidenfrost's Phenomenon.—Th. Salzer.—The author finds it practicable to incinerate organic matters which are either liquid in themselves or can be liquefied by heat in a faintly ignited platinum capsule.

Spectral Apparatus and Spectrum Analysis.—Brief mentions of a variety of appliances from the *Comptes Rendus*, the *Annalen*, and the *Chemiker Zeitung*.

Dispersion - polarimeter.—J. Seyffart.—This instrument consists essentially of a spectroscope giving the spectrum of a strong source of light. Light of a certain refrangibility is selected, and serves as the source of light for the polarising apparatus.

Variation in Weights (*Chemiker Zeitung*).—Decrease is due mainly to friction, and increase, especially in the finer weights, to internal oxidation or to the adhesion of dirt.

Specific Gravities of Salts and Saline Solutions.—G. Th. Gerlach.—The details are not given.

New Proposals for Determining Specific Gravities.—One of the methods proposed is the use of methylene iodide, which at 15° has a sp. gr. of 3·33.

Centrifugal Machine for Laboratory Purposes.—A. Watt.—From the Chemical News.

MEETINGS FOR THE WEEK.

Monday, 28th.—Royal Institution, 9. "Uber die Entstehung der Vitalen Bewegung—On the Origin of Vital Movement," by Professor W. Kühne. (In German).
—— Society of Chemical Industry, 8. "The Prospects of the Coal-gas Industry," by Mr. L. T. Wright.
Tuesday, 29th.—Institution of Civil Engineers, 8. (Anniversary).
—— Royal Institution, 3. "Conventions and Conventionality in Art," by Sidney Colvin, M.A.
Wednesday, 30th.—Society of Arts, 8.
Thursday, 31st.—Royal Institution, 3. "The Growth and Sculpture of the Alps," by Professor T. G. Bonney, D.Sc., LL D, F.R.S., &c.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
—— Telegraph Engineers, 8.
Friday, June 1st.—Royal Institution, 9. "Earthquakes, and How to Measure them," by Professor J. A. Ewing, F.R.S.
Saturday, 2nd.—Royal Institution, 3. "Count Tolstoi as Novelist and Thinker," by Professor C. E. Turner.

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THE CHEMICAL NEWS.

Vol. LVII. No. 1488.

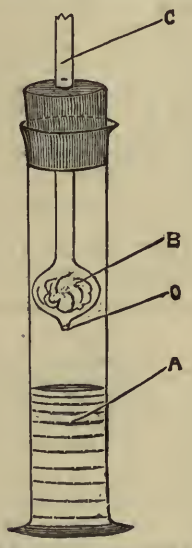
A SIMPLE FORM OF APPARATUS FOR GENERATING GASES BY THE ACTION OF LIQUIDS UPON SOLID SUBSTANCES.

By G. STILLINGFLEET JOHNSON.

The apparatus most in vogue at present for generating such gases as CO_2, H, and H_2S, is that of Kipp. The form of apparatus described below possesses certain advantages over Kipp's, notably on the score of economy.*

The construction of the apparatus will be best understood by reference to the accompanying diagram.

The bulb, B, is blown on a tube, C, and a small aperture is made at O. The solid substance is introduced into this bulb in small lumps (*e.g.*, marble, zinc, or ferrous sulphide) through the tube C. The hole in the cork should be large enough to allow the tube, C, to slide easily in it on the application of a slight degree of force. The liquid, by whose action the gas is to be produced, lies in the cylinder A. Now if the tube, C, be pushed down until the bulb is immersed in the liquid, the latter enters the bulb through O, and generates gas by acting upon the solid in B. The gas escapes through C, and may be led by a delivery tube, joined by rubber tubing to C, into any vessel designed to receive it.



Cylinder A.—Height, 6 inches; internal diameter, 1 inch.
Bulb B.—Diameter, $\frac{3}{4}$ inch.
Tube C.—Diameter, $\frac{1}{8}$ inch; length, 8 inches.

Many advantages which the apparatus possesses will be perceived on using it, but two may be pointed out here. The first is that, when a sufficient supply of gas has been obtained, the tube, C, may be raised till the bulb is out of the acid, when the action ceases.

The second is that the acid may be agitated at any time without disconnecting the delivery tube, thus avoiding cessation of action from spent acid adhering to the solid matter, which is one of the great disadvantages of Kipp's apparatus.

King's College, London,
May 23, 1888.

* F. E. Becker and Co., of Maiden Lane, Covent Garden, supplies the apparatus of the dimensions mentioned in the figure for the sum of 1s.

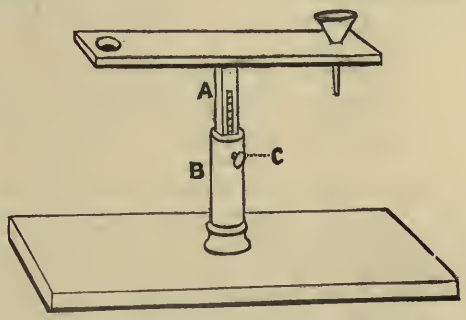
IMPROVED CHEMICAL APPARATUS.

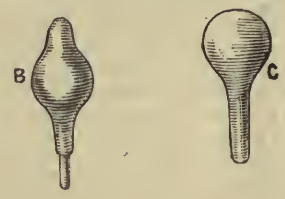
By GEORGE H. BOSTOCK, F.C.S., &c.

I have devised an improved form of filter-stand, in which the inconvenience arising from the projecting end of the rod, on which the support for funnel slides, is done away with. In this form I make use of the rod and socket arrangement. A glance at the accompanying sketch fully illustrates my meaning without further explanation.

A is the rod having the funnel support affixed on its upper end; B is the hollow pillar into which A slides, being held firmly at any height by means of the screw at C.

Any ordinary joiner can make a filter-stand after this pattern.





Having often been annoyed by the frequency with which the valve made of india-rubber tubing—generally used when performing analyses by reduction, &c.—gets out of order and will not act, I was led to make use of a modification the nature of which is explained in a few words:—Instead of the piece of tubing with a slit in it I make a glass bulb, the size of which varies with that of the flask in use, and over this bulb I slip a small piece of india-rubber tubing sufficient to cover the bulb completely. The shank of the bulb should be about 3 c.m. long, and should be dropped into the neck of the flask so that the globular portion rests on the top. When ebullition has entirely ceased, and the flame is removed from under the flask, the partial vacuum caused by the rapidly cooled gases inside draws the bulb tightly down on the flask neck, thus making a perfectly air-tight stopper, which requires considerable force to remove.

A is the neck of the flask; B is the bulb with its covering of india-rubber; and C is the bulb without its covering.

The principal merit of the contrivance is its simplicity and certainty of action.

Widnes, May 14, 1888.

THE ACIDITY OF CARBONIC ACID.

A Lecture Experiment.

By THOMAS FARRINGTON, M.A., F.C.S., F.I.C., Analyst to the County Cork Agricultural Society.

It may not be generally known that the acidity of carbonic acid can be very easily demonstrated by passing a current of the anhydride through a solution of phenolphthalein made slightly alkaline with caustic soda.

The disappearance of the red colour takes place very quickly, and is far more conspicuous than the change from blue to purple in the case of litmus, especially when the experiment has to be performed by artificial light.

To show that the reaction is caused by the gas (and not by hydrochloric acid carried over mechanically), it is only necessary to boil the clear solution, when the red colour will be restored.

4, Waterloo Place, Cork,
May 22, 1888.

ESTIMATION OF TANNIN.

By CH. COLLIN and L. BENOIST.

The authors object to all the methods now in use, including those of Hanmer and Loewenthal, as the gelatinous matter employed retains, mechanically or in combination, a portion of the acids derived from the decomposition of tannin, such as gallic, ellagic, lactic, and butyric acids, a variety of salts, and saccharine matters. Hence they are untrustworthy, both from a scientific and a practical point of view.

The method employed by the authors depends, like some of the older processes, upon the precipitation of gelatin by tannin. They make use of certain standard solutions which must be prepared with great nicety :—

1. Normal solution of tannin : 5 grms. of tannin, absolutely pure and dried in the stove or in a vacuum, are dissolved in 1 litre of distilled water; but before making up the volume to 1 litre they add 0·5 c.c. of a solution of mercuric iodide (1 part in 10) dissolved in an equal weight of potassium iodide. The tannin solution is thus preserved from any alteration of strength arising from fermentation.
2. Standard solution of gelatin : dissolve with heat 5 grms. gelatin in a litre of distilled water; heat to a boil, adding a sufficient quantity of egg-albumen to clarify it. When cold add 0·5 c.c. of the solution of mercuric iodide mentioned above, and render the liquid slightly alkaline by means of a solution of caustic soda.
3. Standard solution of calcium acetate: dissolve 50 grms. of pure dry calcium acetate in 1000 c.c. of distilled water; filter, and then add a few drops of the mercuric iodide to prevent the formation of mould.
4. Solution of pure methylene blue, at 1 per cent.
5. Solution of Nicholson blue, at 4 per cent.
6. Solution of black blue "N.B.I.," at 1 per cent.

   The methylene blue is used in the determination of coloured tannins; either of the two others for coloured tannins and extracts.
7. The burette with a glass cock used in the determinations must have a very tall graduation, so that 1-100th of a c.c. may be read off. The orifice must be drawn out to so fine a point that it may give at least 4 drops to 1-10th c.c. Such burettes have been made specially for the authors by the firm of Alvergniat.
8. A stoppered test-tube, 3 c.m. in diameter, and marked at 60 c.c.

To standardise the solution of gelatin we put into the test-tube 1 c.c. of the gelatin solution, adding 2 drops of methylene blue and 5 c.c. of the calcium acetate, and fill up to the mark with distilled water at 75° to 80°.

By means of the burette a little of the standard tannin solution is run in.

A precipitate is formed, the stopper is inserted, the mixture shaken up and let settle. The precipitate coagulates, and quickly rises to the surface.

We continue thus adding the tannin solution, little by little, shaking after each addition, until the decanted liquid is colourless. At this point all the gelatin is precipitated and the burette is read off.

Having thus determined, by means of the normal tannin solution, the volume required to decolourise the gelatin liquid employed, it is merely requisite, in analysing any tannin liquor, to use it in a second operation in place of the normal tannin. The proportion of the tannic liquors employed in these two operations gives their respective proportion of tannin.

If a solution to be titrated is very rich in tannin, it is well to dilute it previously with four or five times its volume of water. If very acid, they must be rendered but slightly acid by adding a few drops of a solution of caustic soda. The solutions of tannin, gelatin, and calcium acetate, sterilised as above with mercuric iodide, never lose their standard. No change has been discovered after the lapse of four months.

VOLUMETRIC DETERMINATION OF POTASSIUM AND SODIUM.

By JOHN TSAWOO WHITE.

Potassium may be separated from sodium as acid tartrate. A solution of pure acid ammonium tartrate, saturated at about 90° C., diluted with an equal volume of water, is the reagent. When used, the flask containing the reagent is heated till the crystallised tartrate is redissolved.

The salts are in the form of chlorides. Two solutions of potassium and sodium chlorides were prepared to do away with the frequent weighing out of the salts: 20 c.c. of the solution, containing about 0·2 grm., is measured into a 100 c.c. measuring flask; 5 c.c. of ammonium tartrate for every 0·1 grm. added; the solution is allowed to cool, and methylated alcohol is added in small portions, shaking after every addition till up to the mark. Filtered, after about three hours, into a burette, 10 c.c. is evaporated and ignited gently till the charred mass is white. Evaporate with a solution of ammonium chloride, ignite, and titrate the sodium chloride with a solution of silver nitrate, 1 c.c. = 0·001 Cl. Some of the results are given below. The sodium is found directly, and the potassium indirectly.

Taken.		Found.	
KCl.	NaCl.	KCl.	NaCl.
0·0769	—	0·0769	—
—	0·0925	0·0004	0 0921
0·0769 +	0·0925	0·0731	0·0956
0·0769 +	0·0925	0·0763	0 0930

I cannot account for the high result of NaCl of the third experiment, unless it was filtered too soon, an hour after precipitation. The precipitations were usually done in the evenings, and allowed to stand over-night. Three hours were, however, found sufficient from a trial of the mixed chlorides. The filtrate from the precipitate of the

solution of potassium chloride gave no fixed residue. In an early experiment, the adding of spirit at once in quantity lowered the quantity of sodium chloride by 0·0047.

I was led to these experiments by trying to found a method of separation based on the insolubility, discovered by Wurtz, of potassium alum in aluminium sulphate. The potassium of the alum might be determined by precipitating with barium chloride and then with ammonium carbonate, and titrating the potassium chloride formed, but the present process is simpler.

Rangoon College, April 26, 1888.

RESEARCHES ON ALLOISOMERISM.*

I.

By ARTHUR MICHAEL.

(Continued from p. 206).

II.—A Relation between the Constitution of Polybasic Unsaturated Organic Acids and the Formation of their Anilides.

By A. Michael and G. M. Palmer.

Behaviour of Maleic Acid towards Aniline.

It was shown in the preceding paper that an aqueous solution of aniline maleate, on boiling, gives maleic dianilide. A different result is obtained when a solution of acid aniline maleate in ten parts of water is allowed to stand in the cold. After standing a day a crystalline substance was deposited from the solution, which was filtered, and the operation repeated until no further deposit is formed. The crystals were purified by repeated crystallisation from alcohol, and are the acid anilide of maleic acid.

0·1746 grm. substance gave 0·4025 grm. CO_2 and 0·0875 grm. H_2O.

	Theory for $\begin{matrix}CH—CONHC_6H_5\\ \|\\ CH—COOH\end{matrix}$.	Found.
C	62·82	62·91
H	4·71	5·56

The anilide crystallises from dilute alcoholic solutions in almost white prismatic plates, from concentrated solution in plates whose end-faces are imperfectly developed. The crystals melt at 207°. It is soluble in hot water and alcohol, moderately in cold alcohol. Dilute chlorhydric acid does not dissolve it, but it is soluble in dilute aqueous alkalies. Its formation is represented thus:—

$$\begin{matrix}CH—COONH_3C_6H_5\\ \|\\ CH—COOH\end{matrix} = \begin{matrix}CH—CONHC_6H_5\\ \|\\ CH—COOH\end{matrix} + 2H_2O.\dagger$$

Behaviour of Citraconic Acid towards Aniline.

An aqueous solution of mono-aniline citraconate behaves like the maleic acid compound, when it is allowed to stand in the cold. The solution deposits more or less rapidly, according to its dilution, large white crystals, which were crystallised from alcohol.

0·3175 grm. substance gave 0·7531 grm. CO_2 and 0·1532 grm. H_2O.

	Theory for $\begin{matrix}CH_3—C—CO—NHC_6H_5\\ \|\\ CH—COOH\end{matrix}$.	Found.
C ..	64·39	64·67
H ..	5·36	5·37

The compound forms large white rhombic prisms which melt at 175°. It is insoluble in cold water and dilute chlorhydric acid, but dissolves in dilute alkalies to form salts, and acids precipitate the unchanged substance from such solutions. It is soluble in hot alcohol, moderately in cold.

The substance, obtained by Gottlieb* by treating citraconanil with ammonia and precipitating the solution with acetic acid, may be identical with our compound, but, as there are two isomeric acid anilides of citraconic acid possible, the identity must be left to be decided by a more detailed account of Gottlieb's compound, who mentions that a small yield was obtained by his method, while by the method just described almost the theoretical yield can be obtained. Gottlieb describes his compound as small glittering crystals. A solution of dianiline citraconate does not form an anilide on standing in the cold, but on boiling the anil separates. It melts at 98°.

Behaviour of Itaconic Acid towards Aniline.

Anschütz and Petri† and also Markownikoff‡ have observed that itaconic acid or its silver salt, when treated with acetyl chloride, gives an anhydride of the acid. This reaction cannot be considered as a proof that itaconic acid belongs to the maleic acid series, as the method used also causes the formation of anhydrides with acids that certainly do not belong to it, as succinic and pyrotartaric acids. The following experiments on the behaviour of itaconic acid towards aniline show quite conclusively, however, that it is to be classified as a member of the maleic series.

Five grms. of itaconic acid were dissolved in 50 grms. of water, and 3 grms. of aniline added. This solution was heated to boiling for half an hour, in a flask connected with a condenser, and on cooling gave a copious precipitate, which was purified by crystallisation from dilute alcohol.

0·3664 grm. substance gave 0·8657 grm. CO_2 and 0·1804 grm. H_2O.

	Theory for $\begin{matrix}CH_2—C—CO—NHC_6H_5\\ \|\\ CH_2—COOH\end{matrix}$.	Found.
C ..	64·39	64·45
H ..	5·36	5·44

It crystallises in plates that melt at 189°, and is identical with the product obtained by Gottlieb§ by heating solid acid aniline itaconate. It is insoluble in dilute chlorhydric acid, but dissolves in dilute alkalies, and is precipitated unchanged from this solution by adding an acid.

The same compound is formed by allowing a solution of acid aniline itaconate in ten parts of water to stand for several days in the cold, when rhombic prisms that melt at 189° are deposited. It was impossible to obtain the anil of itaconic acid by heating an aqueous solution of its aniline salts.

(To be continued).

* *American Chemical Journal*, Vol. ix., No. 3.

† In view of the differences in the results obtained by Anschütz and Wirtz (*Annalen*, ccxxxix., 148), I repeated this experiment, unfortunately on a small scale, as I had but a few grms. of maleic acid at my disposal. The compound separates as crystalline plates that are soluble in dilute chlorhydric acid, but after several crystallisations from alcohol become insoluble in it, in fact they are insoluble in the strong acid. It is evident that the compound undergoes some change during crystallisation, and I am surprised that Anschütz and Wirtz did not take the trouble to crystallise their product before making note of supposed differences, as it is evident that reference was made in our preliminary note to the crystallised product. In regard to the melting-point, the specimen I examined decomposed partially before that temperature is reached, so that it is impossible to give a well-defined melting-point. The substance dissolves in dilute alkalies, but strong alkaline solutions set aniline free. An analysis of the product gave the following figures:—

0·2878 grm. substance dried in a vacuum gave 0·6087 grm. CO_2 and 0·150 grm. H_2O.

	Theory for $C_{10}H_{11}NO_4$.	Found.
C	57·41	57·68
H	5·26	5·76

The product analysed by Mr. Palmer was probably dried in vacuo at 100°, when it lost a molecule of water, although, as no mention is made in his notes of the conditions of drying, this must remain a surmise on my part. Whether the compound is the acid anilide with a molecule of water of crystallisation, can only be settled by a more detailed examination.—A.M.

* *Annalen der Chemie*, lxxvii., 280.

† *Berichte der Deutschen Chemischen Gesellschaft*, xiii., 1538.

‡ *Annalen der Chemie*, xiii., 1844.

§ *Annalen der Chemie*, lxxvii., 284.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Anniversary Meeting, March 28th, 1888.

Address of the President, William Crookes, F.R.S.*

(Continued from p. 209).

Let us now return to our ultimate atoms, where the case, though much more complicated, is of the same character. We will suppose certain points in space where the first step in differentiation has been achieved. The ultimate particles have commenced to vibrate in their new born energy in all directions, and with velocities ranging from zero to infinity.† The law which we have traced from animated beings and coarse powders, down to the molecules of a rarefied gas, still holds good at this transcendental stage of matter, and the imagination can picture knots and voids gradually forming there as well as in Fleet Street. The slower particles will obstruct the quicker, the more rapid will rush up to the laggards in front, and we shall soon have groups forming in different parts of space. The constituents of each group whose rate of vibration is not in accord with the mean rate of the bulk of the components of that group will work to the outside and be thrown off to find other groups with which they are more in harmony. In time, therefore, a condition of stability is established between the various groups, and we may call these the molecules of our present system of elementary bodies.

With regard to the place where atoms come into existence, it seems to me almost certain that if their existence has had a beginning it has begun at the very edge of the protyle, or the confines of the ponderable Universe, and that their subsequent migrations have always been inwards.

In dynamical language, every new position into which an atom can glide must be from a position of higher to a position of lower potential. If the atom has had a beginning it must therefore have been where the potential is highest, *i.e.*, on the confines of the ponderable Universe, and if it comes to an end it must be where the potential is lowest, *i.e.*, in the centre of overgrown stars; so that the extinction of the central part of a star when it becomes overgrown is that which puts a limit to the size a star can attain by attracting to itself surrounding matter. This assigning of the places where chemical atoms have their origin and where they meet with extinction seems the only—or almost the only—conclusion we can yet with confidence advance.‡

From the above illustrations it will be seen that the constituent atoms of these molecules originally may not have been gifted with exactly the same speed or amplitude of vibration. In the molecule of a certain group let the form of energy which has for a factor what we call atomic weight be represented by the figure 35·5; it follows, from the foregoing exposition—which I have endeavoured to make clear—that whilst the great bulk of its component atoms have this atomic weight, a small percentage may vary from this figure to the extent of a decimal place, while a few others may stray as much as a whole number or two on one side or the other of the mean. The ultimate atoms whose rates are not exactly 35·5, but a little higher or lower than 35·5, will congregate around the 35·5 nucleus, forming a group whose average value will be 35·5. In like manner similar groups will be formed having the average rates of 80 and 127, whilst intermediate spaces will be cleared, the ultimate atoms which occupied these lone spaces being attracted to the chlorine, bromine, and iodine groupings. These groupings represent what at present we call elements, but which I conjecture may possibly consist each of an element and of a certain number of meta-elements, or each may be formed of a whole group of meta-elements, none of which greatly preponderates over the remainder.

On the threshold we encounter an objection very clearly stated by Clerk-Maxwell in his "Theory of Heat" (1871). "I do not think," says this eminent physicist, "that the perfect identity which we observe between different portions of the same kind of matter can be explained on the statistical principle of the stability of the averages of large numbers of quantities each of which may differ from the mean; for if of the molecules of some substance, such as hydrogen, some were of slightly greater mass than others, we have the means of producing a separation between molecules of different masses, and in this way we should be able to produce two kinds of hydrogen, one of which would be somewhat denser than the other. As this cannot be done, we must admit that the quality which we assert to exist between the molecules of hydrogen applies to each individual molecule, and not merely to the average of groups of millions of molecules."

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* From the *Journal of the Chemical Society* for May, 1888.

† Maxwell, "Atom," *Encyclopædia Britannica* (9th Ed.), iii., 40.

‡ For this fruitful suggestion and for other valuable criticism and advice on parts of this address I am indebted to my friend G. Johnstone Stoney, M.A., F.R.S.

Mr. G. Johnstone Stoney has given in the *Times* of April 4th, the following explanation of this passage:—

"There is nothing more certain in physical science than that, if atoms of ponderable matter are generated by any process of nature, they will inevitably thenceforth gravitate inwards towards the rest of the ponderable matter of the universe, and that, therefore, they must have come into existence at a position further out than those through which they subsequently pass. It may further be stated that some at least must have been formed at or beyond the limits now occupied by any ponderable matter. And it is also certain that their extinction, if it arrives at all, must overtake them in the position of lowest potential which they can reach, and that the position of lowest potential is at the centre of the largest star.

"You regard a limit to the universe as having been gratuitously invented for this theory. But have you not here overlooked what we are taught by the other sciences which, along with chemistry, bring us our knowledge of Nature? The lesson to which astronomy points is that the universe is limited. We know that the stars which constitute our Milky Way, our sun, and all the stars we see of a clear night form a detached group. It is certainly possible, and the facts that are known about the nebula in Andromeda make it probable, that there exist other groups of stars as numerous as we see in the Milky Way and scattered over our sky. The spectroscope indicates that that great nebula consists of stars, although their great distance precludes their being seen separately by any telescope, and their aggregate brightness is about the same as that of the Milky Way; in other words, they present very much the appearance which our great group of stars would have if seen from an equal distance. Moreover, a star outburst appeared among them, and has from time to time happened in our part of the universe. From these facts we may with probability infer that this nebula is a group of stars comparable to our great group. But that there are not an infinite number of such groups seems almost certain. It is a familiar theorem in optics that if stars in unlimited numbers sent us their radiations we should have 200,000 times as much light and heat as we actually receive, unless the radiations are absorbed or intercepted on the way to such an extent that only one two-hundred-thousandth part reaches us. This is so improbable that the alternative conclusion, that the universe is limited, is with some emphasis declared by astronomy. It was not, therefore, invented for the exigencies of the chemical hypothesis. Nor is a limited universe necessary for the statement made by Mr. Crookes. Whether limited or not, the ponderable universe consists of detached stellar groups, that of our Milky Way, that of the great nebula in Andromeda, and perhaps some others. The vast celestial spaces between these groups are beyond the confines of the universe in the sense required by Mr. Crookes's statement,—they are outside the universe of ponderable matter.

"Astronomy again comes to our aid with reference to the locality where atoms may become extinguished. Stars are not of all sizes. There is a distinct limit beyond which they cannot be ascertained to grow. The variety of their dimensions is like that found among the pebbles of a gravelled walk. There are none among them which, in comparison, are mountain masses or even boulders. There is, therefore, some cause in nature which puts this limit to their growth. And if chemical elements anywhere meet with extinction, this limitation of the size of stars is fully accounted for. On dynamical principles the extinction of an atom can only occur when it reaches its position of lowest potential, and the position of lowest potential is at the centre of the greatest star.

"It has always appeared to my mind a great recommendation of the hypothesis that there are processes in nature which convert radiant energy into the energy stored up in ponderable matter, that it relieves us from the vastly greater improbability of the only alternative hypothesis, viz., that the entire universe will become motionless and inert through the equable distribution or complete dissipation of its energy."

"The molecules of the same substance are all exactly alike, but different from those of other substances. There is not a regular gradation in the mass of molecules from that of hydrogen, which is the least of those known to us, to that of bismuth: but they all fall into a limited number of classes or species, the individuals of each species being exactly similar to each other, and no intermediate links are found to connect one species with another by a uniform gradation.

"In the case of molecules, however, each individual is permanent: there is no generation or destruction, and no variation, or rather no difference, between the individuals of each species."

"Our molecules are unalterable by any of the processes which go on in the present state of things, and every individual of each species is of exactly the same magnitude, as though they had all been cast in the same mould, like bullets, and not merely selected and grouped, according to their size, like small shot."

I think it evident that the statements here quoted, some of which involve no small amount of assumption, no longer accord with facts, for we actually do find variations between the properties of certain molecules which heretofore had been pronounced identical with each other. Take the case of yttrium. It had its definite atomic weight; it behaved in every respect as a simple body, an element, to which we might indeed add, but from which we cannot take way. Yet this yttrium, this supposed homogeneous whole, on being submitted to a certain method of fractionation, is resolved into portions not absolutely identical among themselves, and exhibiting a gradation of properties.

Or take the case of didymium: here was a body betraying all the recognised characters of an element. It had been separated with much difficulty from other bodies which approximated closely to it in their properties, and during this crucial process it had undergone very severe treatment and very close scrutiny. In short, until lately we might have said of it just what Clerk-Maxwell says of hydrogen, that the equality which we assert to exist between the molecules of didymium applies to each individual molecule, and not merely to the average of groups of millions of molecules. But then came another chemist who, treating this assumed homogeneous body by a peculiar process of fractionation, resolved it into the two bodies praseodymium and neodymium, between which certain distinctions are perceptible. Further, we even now have no certainty that neodymium and praseodymium are simple bodies. On the contrary, they likewise exhibit symptoms of splitting up.

Now if one supposed element on proper treatment is thus found to comprise dissimilar molecules, we are surely warranted in asking whether similar results might not be obtained in other elements, perhaps in all elements, if treated in the right way? We may even ask where the process of sorting-out is to stop? a process which of course presupposes variations between the individual molecules of each species.

And in these successive separations we naturally find bodies approaching more and more closely to each other. Dr. Auer von Welsbach, the discoverer of neodymium and praseodymium, remarks that these bodies "approximate more closely to each other than any two supposed simple bodies yet known." Thus we approach nearer and nearer either to a regular gradation in the molecules or to the recognition of those intermediate links, which I have named "meta-elements" or elementoids. A suggestion here occurs that it may be to the presence of these meta-elements that so many of the chemical elements, whilst approaching closely in their atomic weights the values required by Prout's law, deviate from it by a small but measurable amount. We can scarcely regard their approximation as purely accidental.

(To be continued).

Ordinary Meeting, May 17th, 1888.

Mr. William Crookes, F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. John Alexander, M.A., 14, Caledonia Place, Perth; Charles Bradshaw, 174, Nottingham Street, Sheffield; Lewis Edmunds, 8, Grafton Street, Piccadilly, W.; William Humphrey Gibson, 107, King's Road, Brighton; Joseph Henry Maiden, Sydney, New South Wales; Henry Alexander Miers, M.A., Eden Cottage, Beckenham, Kent; Frank Mousley, Phillimore Terrace, Walham Green, S.W.; James Henry Rymer Paterson, 10, Millerfield Place, Edinburgh; George Woodyatt Procter, 18, Alice Street, Sunderland; Herbert W. Seeley, 11, Corn Market, Halifax.

The following were elected Fellows of the Society:—George Thomas Evans, John Campbell Fell, Albert Harrison, John Burchmere Harrison, M.A., Egbert Grant Hooper, John Hughes, Henry James Kirkman, William Parsons, Henry Charles Reynolds, Frank Goodell Wait.

The following papers were read:—

40. "*Researches on the Constitution of Azo- and Diazo-derivatives. IV. Diazo-amido-compounds.*" By Professor Meldola, F.R.S., and F. W. Streatfeild.

Expressing the constitution of the mixed diazo-amido-compounds by the general formula $X{\cdot}N_3H{\cdot}Y$, the authors point out that in former papers they had given evidence that the alkyl derivative $X{\cdot}N_3R'{\cdot}Y$ was capable of existing in three isomeric modifications:—(1) from the action of $X{\cdot}N_2{\cdot}OH$ on $Y{\cdot}NH{\cdot}R'$; (2) from the action of $Y{\cdot}N_2{\cdot}OH$ on $X{\cdot}NHR'$; (3) from the direct alkylation of the compound produced by the action of $X{\cdot}N_2{\cdot}OH$ on $Y{\cdot}NH_2$, or of $Y{\cdot}N_2{\cdot}OH$ on $X{\cdot}NH_2$.

The only known case at present established is that of the ethyl derivatives of para-meta-dinitrodiazoamidobenzene, and the object of the present investigation has been to obtain other series of isomeric triplets. The triplet of methyl-derivatives is first described. By the direct methylation of the mixed para-meta-compound a derivative of m. p. 148° is obtained. By the action of diazo-*p*-nitrobenzene chloride on methyl-*m*-nitraniline a derivative is obtained melting at 168°. The third isomeride, formed by the action of diazotised *m*-nitraniline on methyl-*p*-nitraniline, melts at 176—177°. The triplet is thus shown to confirm the isomerism indicated by the ethyl-derivatives. Methyl-derivatives of *p*-dinitrodiazoamidobenzene (m. p. 219°) and the corresponding *m*-compound (m. p. 127—128°) have also been prepared. A considerable number of other new diazoamido-compounds have been obtained in the course of a search for triplets of alkyl-derivatives, of which two members at least are required as solids. It has been found that mixed diazoamido-compounds cannot be obtained from the nitranilines and *p*-chloraniline, as the resulting product is always a mixture of the two symmetrical compounds. A very small quantity only of the mixed compound—

$$(p)NO_2{\cdot}C_6H_4{\cdot}N_3H{\cdot}C_6H_4Cl(p)$$

is formed under certain conditions by the action of diazotised *p*-nitraniline on *p*-chloraniline. In conclusion, the authors give a series of numerical results obtained by the analytical method described by them in a former paper, and which show that the amount of azonaphthol compound, $X{\cdot}N_2{\cdot}C_{10}H_6{\cdot}OH\beta + Y{\cdot}N_2{\cdot}C_{10}H_6{\cdot}OH\beta$, produced by the decomposition of the diazoamido-compounds by hydrochloric acid represents the quantitative resolution:—

$$2X{\cdot}N_3H{\cdot}Y + 2HCl = X{\cdot}N_2{\cdot}Cl + X{\cdot}NH_2 + Y{\cdot}N_2{\cdot}Cl + Y{\cdot}NH_2.$$

41. "*The Colour of some Carbon Compounds.*" By Thomas Carnelley, D.Sc., and John Alexander, M.A., University College, Dundee.

A careful investigation of a number of metallic derivatives of ortho- and para-nitrophenol has given the fol-

lowing results:—(1) In all cases without exception the colour passes towards the red end of the spectrum as the temperature rises. Organic compounds thus behave like inorganic substances. (2) The colour of the ortho-derivative is nearer the red end than that of the corresponding para-compound. Para-compounds almost always melt higher than either of the corresponding ortho- or meta-compounds, and the probability is that of two isomeric bodies which are of different colour the one with the lower melting-point will have a colour near the red end of the chromatic scale than the one with the higher melting-point. This is only what we should *a priori* expect, for the compound with the lower melting-point is at a correspondingly higher temperature than the other, and according to (1) the higher the temperature the more does the colour pass towards the red end. (3) A comparison of the nitrophenates of metals belonging to the same sub-group shows that the colour passes towards the red end as the atomic weight of the metal increases. This accords with the results observed by one of the authors (*Phil. Mag.*, 1884 [5], xviii., 130) in the case of inorganic salts. (4) When the same salt occurs in both the anhydrous and hydrated state, the colour passes towards the red end as the quantity of water of crystallisation diminishes. The exceptional behaviour in this respect of such inorganic salts as copper sulphate is possibly due to the breaking down of the crystals on dehydration, which of itself frequently makes a coloured body become white or nearly so. (5) As regards the salts investigated, the para-compound always takes up a larger quantity of water of crystallisation than the corresponding ortho-compound.

Discussion.

Dr. Armstrong remarked that the facts advanced were far too few to justify the very general conclusions arrived at by the authors; all who had worked with the nitrophenols were well aware that the colour changed on heating in the manner described; and there was no novelty in the statement that the paranitrophenates crystallised with the larger proportion of water. Referring to the suggested explanation of the colourlessness of dehydrated copper sulphate, he quoted calcium para-chlorodiorthonitrophenate as one of the exceptions to which such an explanation did not apply: this compound could be obtained either in yellow anhydrous crystals, or in deep orange hydrated crystals.

Mr. Friswell mentioned magnesium and barium platinocyanide as instances of loss of colour taking place without loss of crystalline form; the hydrated magnesium compound was of a splendid red colour, but when gently heated it became lemon-yellow, and when anhydrous it was white; if care were taken, the dehydration could be effected without the slightest apparent injury to the crystals.

Professor Thorpe said that he and Professor Judd had recently had occasion to examine the cyanides referred to, and he thought that in reality the dehydrated crystals were mere pseudomorphs.

Mr. Warington mentioned having succeeded in expelling the ammonium sulphate from ammonium magnesium sulphate without changing the form of the crystals.

42. "*The Identity of Natural and Artificial Salicylic Acid.*" By W. N. Hartley, F.R.S.

In order to determine whether natural and artificial salicylic acid are the same substances, specimens prepared by Kolbe's process and from oil of winter-green were carefully recrystallised and examined by means of the spectrum. They were found to give identical series of photographs, and hence the same curve.

43. "*Researches on the Relation between the Molecular Structure of Carbon Compounds and their Absorption-spectra.* (Part VIII.)" By W. N. Hartley, F.R.S.

Isomeric Cresols, Dihydroxybenzenes and Hydroxybenzoic Acids.—The ultra-violet spectra of these substances were carefully examined, with the object of ascertaining how far they are alike or different from each other.

The *oscillation frequencies* of the extreme rays transmitted by 1 m.grm.-molecule of the four series of substances, including xylenes previously examined, are the following:—

	Xylenes.	Cresols.	Dihydroxy-benzenes.	Hydroxy-benzoic acids.
Ortho	3611	3433	3466	3359
Meta	3580	3413	3399	3080
Para	3537	3359	3151	2986

It appears from this table that the law which determines the order of greatest absorption is not the same in the series of isomeric hydrocarbons as in the series of cresols and dihydroxybenzenes. In the hydroxybenzoic acids it is the reverse of that in the xylenes.

The curves of molecular vibrations afford evidence of the relative extent to which energy is dissipated during the formation of the molecules of the substances, and they are classified according to the indications of the curves.

44. "*A Definition of the Term Atomic Weight and its Reference to the Periodic Law.*" By W. N. Hartley, F.R.S.

The atomic weights are too frequently viewed by those who become familiar with them in the capacity of teachers or as students, either as proportional weights, as combining weights, or as mere numbers with which calculations can be made for analytical or other purposes. That they are real measures of the *quantity of matter* in the atoms of the elements is often overlooked. The reason of this is due to the ambiguous use of the word *weight*. A weight is a measure of the attraction between the earth and the matter weighed, or, as it is more familiarly stated, a measure of the *earth's attraction* for the body weighed. The common method of determining relative quantities of matter is by weighing, and though the determination of the weight of a body does not actually determine its mass, yet the weight of a substance is proportional to its mass.

A so-called atomic weight is therefore a numerical proportion. There are 70 elements and 70 atomic weights, and these represent 70 different quantities of matter in 70 different atoms; or in other words, they represent matter in 70 different states of condensation.

I am of opinion that the teaching of chemistry is very much facilitated by the use of the following definition, which I have used for some years past, and I would recommend its general adoption:—*The atomic weight of an element is the ratio of the mass of its atom to the mass of an atom of hydrogen.*

The term atomic weight should be abolished and atomic mass substituted. Similarly, molecular weight should be defined as the *mass of a molecule* or *molecular mass*. The statement that the molecular weight of a compound is the sum of the weights of the atoms of the elements contained in it becomes simplified thus:—*The mass of a molecule is the sum of the mass of its constituent parts.*

Whatever remarks are applicable to the inconveniences arising from the term atomic weight, they may be emphasised in dealing with the Periodic Law. If we accept it as correctly stated, thus:—The properties of the elements are a periodic function of their atomic weights; then the ambiguous use of the word weight, and the tendency to see in the atomic weights only a series of numbers, obscures the true meaning of the law. A quotation from a recently published paper of great interest affords evidence that an important corollary of the law has been overlooked. Thus, Professor Roberts-Austen refers to the fact that Carnelley has given strong evidence in favour of supplementing the law as follows:—"The properties of *compounds* of the elements are a periodic function of the atomic weights of their constituent elements." (*Proc. Roy. Soc.*, xliii., 425, 1888). This was recognised by Mendeleeff, for he headed the columns in his table of the

atomic weights with their most characteristic oxygen and hydrogen compounds, such as—

$$M_2O,\ MO,\ M_2O_3,\ \begin{matrix} H_4M \\ MO_2 \end{matrix},\ \begin{matrix} H_3M \\ M_2O_5 \end{matrix},\ \&c.$$

Furthermore he predicted the properties of the various hydrates, oxides, and salts of scandium with most remarkable accuracy when he described those of eka-boron. Inasmuch as the properties of compound substances depend almost entirely upon their composition, and that both the chemical and physical properties of the elements are a periodic function of their so-called atomic weights, it follows that the periodical relationship must influence the compounds into which the atoms enter. During the last six years I have made a practice of stating the periodic law in a much more concise and, at the same time, comprehensive manner, thus:—*The properties of the atoms are a periodic function of their masses.*

Thus the chemical and physical properties of both elements and compounds are directly connected with the quantity of matter entering into them.

In any graphic representation of the periodic law the fact that it is upon the mass of the atoms that their properties depend should appear prominently. The diagram of Dr. G. Johnstone Stoney, F.R.S., used to illustrate his paper on the "Logarithmic Law of Chemistry," recently read before the Royal Society, has on this account alone a pre-eminent importance.

The elements are distributed on a logarithmic curve of the second order, their masses being represented by volumes which are proportional to radii by which the curve is described, and which are derived from numbers which are the cube roots of the atomic weights. Its most essential feature is a representation of the ratios of the masses of the atoms of other elements to the mass of the atom of hydrogen, and the consequent variation in chemical and physical properties accords with the positions of the elements upon the diagram.

At the next meeting on June 7th there will be a ballot for the election of Fellows, and the following papers will be read:—

"The Chemical Action of some Micro-organisms." By R. Warington, F.R.S.

"The Optical and Chemical Properties of Caoutchouc." By J. H. Gladstone, F.R.S., and W. Hibbert.

NOTICES OF BOOKS.

Handbook of Modern Chemistry, Inorganic and Organic. For the Use of Students. By Charles Meymott Tidy, M.B., F.C.S., Professor of Chemistry and of Medical Jurisprudence and Public Health, at the London Hospital. (Second Edition, revised and enlarged). London: Smith, Elder, and Co.

This work occupies an intermediate position between the comprehensive treatises of Gmelin, Watts, Miller, or Roscoe and Schorlemmer, and, on the other hand, the slighter handbooks, manuals, and vade-mecums which are now quite sufficiently plentiful. Dr. Tidy writes more especially for the use of medical students,—a praiseworthy undertaking if we consider that not a few practitioners of standing are not too well versed in chemical science, and are sometimes even accused of combining in one prescription substances which respectively decompose each other.

The views expressed by the author in his Preface and in the "Epistle Dedicatory" seem to us practical and judicious. He omits the constitutional formulæ which he has used in his lectures, remarking that "On the whole it seems preferable, in view of the many-sided relationships of different chemical compounds, to avoid their systematic representation of any single scheme of constitutional formulæ, necessarily representing them in a single aspect only."

In nomenclature the writer is less of a precisian than many of his contemporaries. If he is understood he feels, not unjustifiably, satisfied. He remarks:—"I confess that the growing necessity for having a translation at one's side in attempting to understand the modern scientific paper is, in my opinion, a circumstance to be deplored. Danger, moreover, is always to be apprehended when a language has to be invented to support a theory or a formula. A party shibboleth has no doubt a charm for its special clique. It serves as a bond of union for the uninitiated, whilst it prevents the interference of outsiders. But, all the same, it is distracting to the general worker, and can but prove a hindrance to the general cultivation of Science."

Carrying out these views we find Dr. Tidy, instead of the alien terms "perissads" and "artiads," using the plain English words "odds" and "evens," which are shorter, quite as precise, and are certain to be "understanded of the people." It would be well if biologists, both British and American, would follow this wholesome example.

The general principles of the chief chemical manufacturers are here given, as such knowledge is in many districts absolutely essential for medical officers of health. The descriptions of the plant and processes are of necessity somewhat brief, but a fuller account would scarcely have been practicable within the compass of the work.

As regards the periodic law it may be questioned whether sufficient prominence has been given to Mr. Newlands's share in this capital discovery.

The recent results obtained by Thomsen and Berthelot in thermo-chemistry are very clearly summarised.

As a whole the work seems to us admirably well adapted for the use of medical students.

The International Scientists' Directory: containing the Names, Addresses, Special Departments of Study, &c., of Amateur and Professional Naturalists, Chemists, Physicists, Astronomers, &c. Compiled by S. E. Cassino. Boston: S. E. Cassino.

We have here an exceedingly useful work, the compilation of which must have involved enormous difficulties. We find certainly the names of some well-known scientific men wanting, but if they have neglected to fill up and return the forms sent them the editor cannot be fairly blamed.

In looking over the names here catalogued we are struck with the very extensive list of specialities to which some persons lay claim,—some of them, moreover, not very closely connected. Thus one gentleman cultivates botany, geology, mineralogy, crystallography, lithology, metallurgy, electricity, bibliography, taxidermy, and entomology; another is devoted to botany, horticulture, geology, mineralogy, chemistry, metallurgy, physics, electricity, photography, anatomy, and entomology; a third studies ornithology, oology, geology, crystallography, palæontography, land and fresh-water shells, war (!), historical and mound-builders' relics, numismatics, and philatry—whatever the last word may mean. We can only hope that these three gentlemen, and a few others who might be named, have made their arrangements to live to the age of Prof. Chevreul, whose name, by the way, does not figure in this Directory.

The Compounds of Cuprous Chloride, Bromide, and Iodide with Aniline.—André Saglier.—Cuprous chloride, bromide, and iodide, if heated in excess with aniline in sealed tubes, form a series of compounds perfectly crystalline, and corresponding to the formulæ of the cupro-ammonium salts.—*Comptes Rendus*, cvi., No. 20

CORRESPONDENCE.

ON SOLUTION.

To the Editor of the Chemical News.

Sir,—Dr. Durham accuses me of having made two errors in stating the signs of certain quantities in my criticism of his paper on this subject. He is quite right, and I apologise. But he is somewhat too hasty (to use a mild expression) in attempting to dismiss the criticism by stating that "the other instances given are of a precisely similar nature, and need no further comment," for a more careful examination of my statements would have shown him that these two errors exactly counterbalanced each other (being, in fact, mere errors of transcription), and did not affect in the least my final results. He had only to take his original equation (stated correctly) and substitute determined for the undetermined quantities contained in it (correcting the error that I had made in one of these), and he would have got the same results as I did. Thus: Dr. Durham states, as a discovery fraught with theoretical importance, that—

$$Ca,Cl_2 - Ca,O,Aq - Mg,Cl_2 + Mg,O,Aq = \\ = MgCl_2,Aq - CaCl_2,Aq.$$

The first four terms cannot be determined directly, but are calculated in the following manner:—

$$Ca,O,Aq = R + H_2,O$$
$$Ca,Cl_2 = 2(H,Cl,Aq) + R + N - CaCl_2,Aq$$

R being the heat evolved when the metal is dissolved in water, and N the heat of neutralisation of the resulting solution with hydrochloric acid. With magnesium compounds we have a different value for R, say R′, but the same value for N. Hence Dr. Durham's equation becomes:—

$$[2(H,Cl,Aq) + R + N - CaCl_2,Aq] - [R + H_2,O] - \\ [2(H,Cl,Aq) + R' + N - MgCl_2,Aq] + [R' + H_2,O] = \\ = MgCl_2,Aq - CaCl_2,Aq$$

Cancelling those terms which occur twice with opposite signs, this simplifies (as I stated) into—

$$MgCl_2,Aq - CaCl_2,Aq = MgCl_2,Aq - CaCl_2,Aq \\ \text{or } 18{,}510 \text{ cal.} = 18{,}510 \text{ cal.}$$

an obvious truism, by which science will not be much benefitted.

If Dr. Durham knew, as he implies he did, that the quantities on one side of his equation were dependent on those of the other side, it was inexcusable in him to give (as he did in one case) one side as =985 cal., and the other as =990 cal., implying that this concordance of "found" and "calculated" values proved the justness of his theory, when both the values are the "found" values for the *same* quantities, and must necessarily be identical.

As to my views on residual affinity, I certainly might have claimed originality, but as Dr. Durham will find on reference to my first communication on the subject "Atomic Valency," and Pamphlet, *Chem. Soc. Proc.*, 1885, 122, I was very careful in not claiming any priority in the enunciation of such views.

In conclusion, I must thank Dr. Durham for his kind wishes as to the prolongation of my life for another seven years, but I very much doubt whether such a period will be long enough to convert me to his methods of interpreting thermo-chemical data.—I am, &c.,

Spencer Pickering.

Harpenden, May 15, 1888.

Reaction of Thymol.—R. Stormer.—If thymol is dissolved with the aid of heat in moderately strong potassa lye and a few drops of chloroform are added, there appears at once a violet colour.—*Zeit. Anal. Chem.*, xxvi., Part 5.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of emperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 20, May 14, 1888.

Fluorescence of Cupriferous Lime. — Lecoq de Boisbaudran. — Calcium carbonate containing a little copper oxide gives, after ignition in contact with air, a substance which shows in a vacuum an extremely brilliant light green fluorescence. No spectral rays were distinguished.

Action of Hydrochloric Acid upon the Solubility of Stannous Chloride. — M. Engel.— It is generally admitted that the solubility of stannous chloride in water increases in presence of hydrochloric acid. This is true only when the quantity of acid added to the saturated solution of the chloride exceeds a certain proportion. It is possible to obtain a definite hydrochlorate of stannous chloride.

The Existence of a Pyrophosphorous Acid. — L. Amat. — The author obtains sodium pyrophosphite by heating sodium monophosphite to 160°. The salt loses 6 mols. of water, and is converted into the pyrophosphite.

The Composition of the Hydrates of Sulphuretted Hydrogen and of Methyl Chloride.—MM. de Forcrand and Villard.—The authors conclude from their experiments that the formula of hydrated methyl chloride is $C_2H_3Cl + 18HO$, whilst that of hydrogen sulphide is $HS+7HO$.

Essay on the Equivalents of the Simple Bodies.—M. Delauney.—This paper will be inserted in full.

Researches on the Synthesis of the Albumenoid and Proteic Matters.— P. Schützenberger.—Any proteic matter treated in heat with a solution of barium hydroxide takes up the elements of water and is split up into various products belonging to one of three categories. (1) Products of the scission of urea and oxamide by hydration: ammonia and the carbonic and oxalic acids. (2) leucines; and (3) leuceines.

On Cinchonibine.— E. Jungfleisch and E. Leger. — This compound, $C_{38},H_{22}N_2O_2$, is an isomer of cinchonine. It forms small colourless rhomboidal prisms, strongly refractive. It melts at 259°, and if heated suddenly it sublimes with little change of colour. It is insoluble in water, ether, and weak alcohol, but dissolves in strong alcohol with the aid of heat. It is biacid, and its basic salts turn litmus slightly blue.

Syntheses by Means of Cyanacetic Ether. — Alb. Haller and L. Barthe.—The authors have obtained two new compounds, the cyano-succinic and cyano-tricarballylic ethers.

Preparation of Methyl-benzoyl-cyanacetate and of Cyanacetophenone,—L. Barthe.—The author has prepared methyl-benzoyl-cyanacetate by treating sodium methyl-cyanacetate by benzoyl chloride.

The Oil of Eucalyptus Globulus.—R. Voiry.—The author has obtained eucalyptol in a state of purity. It is a colourless mobile liquid, of the sp. gr. 0·940; its formula is $C_{20}H_{18}O_2$; it melts at +1° and crystallises at 0°.

The Combination of the Anhydrides of Mannite with Oil of Bitter Almonds.—J. Meunier.—The author has obtained with benzoyl a compound in which 3 mols. of benzoic aldehyd replace three of the mols. of water of the original mannite.

Presence of Maleic Acid in the Sweat of Herbivora.—A. and P. Buisine.—The authors have detected malic acid in the "suint" waters obtained in abundance in the industrial washing of raw wool.

Zeitschrift fur Analytische Chemie.
Vol. xxvi., Part 5.

Filter-cutting Apparatus. — Göttig. — The author (*Chemiker Zeitung*) proposes hollow steel cylinders sharpened at one end, like cork-borers.

Apparatus for Continual Washing. — P. Raikow (*Chem. Central-Blatt*).—An apparatus in which the level of the water is regulated by a float. It flows down upon the precipitate in the funnel through a syphon until the level is the same in both vessels.

A Refrigerator.—H. Michaelis (*Chemiker Zeitung*).—A Liebig's condenser with its cooling tube bent at right angles, and passing through an oblique perforation of the stopper of the upright distillatory vessel.

Continuously-acting Suction-apparatus. — F. Molnár (*Repertorium der Analyt. Chemie*).—This paper requires the accompanying figure.

Improved Analytical Apparatus.—R. Bensemann.—These appliances, including an absolvent receiver for distillations and an extraction-apparatus, cannot be described without the accompanying figures. Full accounts may be found in the *Repertorium fur Analyt. Chemie.*

Apparatus for Determining Hydrogen Peroxide in Commercial Samples.—Maurice de Thierry.—From the *Comptes Rendus.*

Improvements in Burettes.—C. Meissner.

Ether Pipette for the Areometric Determination of Fat in Milk.—F. Soxhlet.

Continuous Gas-generator. — Chr. Steenbuch. — These three papers cannot be reproduced without the accompanying figures.

Use of Phosphoric Anhydride for Drying Gases.—J. Walter.—From the *Journal fur Prakt. Chemie.*

Absorbents for Vapour of Carbon Disulphide.—A. Eiloart.—From the Chemical News.

Substitutes for Sulphuretted Hydrogen and Ammonium Sulphide in Chemical Analysis.—H. Hager.—The author proposes potassium or ammonium sulphocarbonate and ammonium sulphocarbaminate.

Lead Chromate in Elementary Analysis.—Ljubavin.—Lead chromate often evolves, on ignition, carbonic acid, and may occasion errors in organic analysis. "Th. P.," writing in the *Chemiker Zeitung*, recommends that the chromate should be fused in a copper crucible.

Potassium Tetra-oxalate for Standardising Permanganate Solutions.—R. Ullbricht recommends this salt, which was proposed by K. Kraut thirty years ago, and has since been regularly used in his laboratory.

Volumetric Determination of Barium, Strontium, and Calcium.— O. Knöfler.—The author adds to the solution in question a mixture of phenolphthalein and methyl-orange (1 grm. of each in 250 c.c. alcohol). Hydrochloric acid is added to incipient acidity (reddening of the methyl-orange), and heated to boiling, which is continued if necessary until any carbonic acid present is expelled. A one-fifth normal solution of sodium carbonate is then run in; the alkaline reaction which appears at first disappears at once in case of barium and strontium, aad after a few seconds in calcium salts. As soon as a faint rose colour remains, 1 c.c. of the soda solution is added and the deep red liquid is filtered through a wet folded filter and washed once with water. The filtrate is immediately titrated back with one-fifth normal sulphuric acid, until the final reaction with methyl-orange appears. The volume of the soda solution, after deducting the number of c.c. of acid corresponding to the quantity of the alkaline earth present. Ammonium salts must not be present. Magnesium salts cannot be titrated in this manner.

Separation of Iron Oxide and Alumina.—Vignon.—The author adds to the dilute solution an excess of trimethylamine and filters after twenty-four hours. All the ferric oxide remains on the filter, whilst the alumina passes into solution. Chromium oxide may be separated from iron in the same manner.

Separation of Uranium from Alkaline Earths and Alkalies.—A. Remelé.—The author recommends ammonium sulphide as the best reagent for this purpose, except in case of barium. Recently Foullon and also Alibegoff find that uranium and calcium cannot be separated in this manner. Foullon recommends in this case the use of ammonium oxalate in a solution previously rendered alkaline by ammonium carbonate. He first mixes the hydrochloric solution with a little ammonium oxalate, and then adds ammonium carbonate until all the uranium oxide is re-dissolved; ammonium oxalate is then added in excess, and let deposit in the absence of strong light. Alibegoff, working in this manner, obtained better results than with ammonium sulphide, but the calcium oxalate was always more or less contaminated with uranium. He therefore adds to a solution of uranium chloride some elutriated mercury oxide, when the uranium is completely deposited on boiling, and the supernatant liquid has quite lost the colour of the uranium salts. In case of uranium solutions in the oxygen acids, a solution of ammonium or sodium chloride is added. A very dilute solution of ammonium chloride is used for washing; as the precipitate, a mixture of uranyl hydroxide and basic mercury uranate, is slightly soluble in water. In carrying out this method the author adds to the solution of uran-oxychloride a few drops of an ammonium chloride solution, and heats to a boil. He then adds the pure elutriated mercuric oxide, carefully avoiding excess. After again boiling and shaking round (in preference to stirring) let cool, when the precipitate settles quickly, and the liquid becomes colourless. Decant a few times, bring upon the filter, and wash in cold water containing ammonium chloride. The precipitate along with the filter is heated in a platinum crucible, carefully at first, then in the uncovered crucible with a gradually increasing heat, and lastly over a blast. The product is weighed as the olive-green uranious uranic oxide. In presence of uranium and calcium the process is the same. If the alkaline earths are in very large proportion, their partial precipitation may be avoided by boiling up once more after decantation with water containing ammonium chloride. In the filtrate the strontium and calcium are determined in the usual manner after removing the mercury with ammonium sulphide. Uranium may be separated from magnesium by boiling with a sufficiency of ammonium chloride and then precipitating with mercuric oxide as above.

Opening up Tin Ore.—W. Hampe (*Chemiker Zeitung*).—The author weighs the mineral, very finely ground in a porcelain boat, which he places upon a platinum foil in a tube of very infusible glass. He passes pure dry hydrogen gas through the tube, and heats to redness for one to two hours. The water formed during the reduction can be collected and weighed by known methods. When cold the contents of the boat are treated at a gentle heat with dilute hydrochloric acid, and any undissolved residue is filtered off and again submitted to the same operation. The tin is thrown down from the hydrochloric solution by sulphuretted hydrogen, and the precipitate and filtrate are treated in the ordinary manner. By this process insoluble silicates, aluminates, &c., are separated from the tin-stone and admit of a separate examination.

Delicate Detection of Arsenic. — O. Schlickum (*Pharm. Zeitung*).—If a minute crystal of sodium sulphite (0·001 to 0·002 grm.) is placed in a solution of 0·3 to 0·4 grm. stannous chloride in pure hydrochloric acid (sp. gr. 1·124) there is liberated not merely sulphurous acid but hydrogen sulphide, the latter owing to the reductive action of the stannous chloride upon the sulphurous acid. If some arseniferous hydrochloric acid is cautiously poured over it, there appears, if only 1-20th m.grm. of arsenious acid is present, a yellow ring of arsenic sulphide at the line of junction of the two liquids. This ring gradually increases up-

wards, and if ½ m.grm. is present it colours the entire upper stratum of acid yellow in the course of a few minutes. With arsenic acid the reaction requires a few minutes, but it may be obtained even with 1-20th m.grm. arsenic acid if the test-tube is placed in warm water. This process succeeds in presence of bismuth and antimony, as the sulphides of these metals do not form in a strong hydrochloric solution. The only conditions are the use of strong hydrochloric acid and of a minimum of sodium sulphite.

On Arsenic Pentasulphide. — Leroy W. McCay. — From the Chemical News.

Determination of Phosphoric Acid.—C. Meinecke. —The author proposes an abridgment of the molybdic method. If the ordinary yellow precipitate is heated to 400° to 500°, water and ammonia are expelled, and there remains a molybdenum phospho-molybdate almost of a black colour. This compound, within certain limits of temperature, is very permanent, and as it is not hygroscopic it can be weighed. The author proceeds as follows:—The solution of the phosphate, prepared as usual, and containing nitric acid and from 20 to 25 per cent ammonium nitrate, is precipitated at 50° to 60° with solution of molybdic acid, stirring constantly, and is allowed to stand for some hours without further heating, but with diligent stirring. After two to three hours the precipitate is collected on a filter, washed with a 20 per cent solution of ammonium nitrate slightly acidulated with nitric acid, until ten drops react neither with hydrogen sulphide nor (if iron is present) with potassium ferricyanide, and then a few times with cold water, or once each with a small quantity of cold water, alcohol, and ether. The dried precipitate is removed as completely as possible from the filter into a flat platinum capsule. The filter is incinerated separately at the lowest possible temperature in a platinum crucible, the ash is added to the bulk of the precipitate in the flat capsule, which is then covered with sheet platinum and ignited over a "Maste" burner with a triple air current at a temperature which suffices for a slow decomposition of the precipitate, indicated by blackening. If there is a considerable quantity of precipitate it is removed, after a time, from the flame, crushed with a glass rod having its end melted broad and flat, and heated again, bringing the yellow portions, which still remain unchanged, nearest the sides of the capsule which are hottest. In about fifteen minutes the mass is generally of a uniform blackness. It is let cool in the exsiccator and weighed. It contains 4·018 per cent P_2O_5. The residue can easily be removed from the capsule by means of dilute ammonia. If the temperature has been too high, and the residue has a light grey reflection, indicating partial formation of molybdic acid, the operation is not to be rejected. The mass should be carefully moistened with dilute ammonia, dried up, and heated afresh, but with caution in order to avoid loss by spirting.

Determination of Fluorine in Commercial Phosphates.—A. Chapman.—From the Chemical News.

Volumetric Determination of Nitrous Acid.— A. G. Green and F. Evershed (*Journal of Society of Chem. Industry*) have developed a method proposed by A. G. Green and S. Rideal in the Chemical News.

Reagent for the Hydroxyl Group.—H. A. Landwehr. —The author proposes ferric chloride as a reagent, which gives characteristic colours with the phenoles and ortho-oxy-acids. The reaction occurs only if the hydroxyl is intact, and does not take place if the hydroxyl-hydrogen has been substituted by acid or alcohol radicles. Ferric chloride gives also a coloured reaction with bodies of the fatty series containing the hydroxyl group, but the ferric chloride must be very much diluted.

A Coloured Reaction of the Ortho-diketones.—E. Bamberger.—The author dissolves a trace of the substance in question in alcohol and adds to the hot solution a drop of caustic lye, avoiding access of air. There appears a dark red colour, almost black in case of very strong solutions, which disappears on shaking with air.

Coloured Reactions for Determining the Constitution of Carbon Acids of the Pyridin, Chinolin, and Analogous Series.—H. Skraup.—No details are given.

Detection of Pyrogallic Acid.—G. Kliebahn.—The author converts pyrogallic acid into rufigallic acid by fusion with ammonium oxalate. The mass obtained dissolves in water with a red colour and gives the following reactions: — Potassium ferricyanide and potassium dichromate give a dark brown precipitate. Ferric chloride produces no blackening. Potassium cyanide and mercurous nitrate give a black precipitate if the solution has been acidulated with acetic acid.

Detection of Salicylic Acid. — O. Curtman. — If phenol is present the author mixes the sample in a test-tube with 1 c.c. methylic alcohol and adds carefully ½ c.c. strong sulphuric acid. He then heats to a boil, sets it aside, and boils again. The odour of the salicylic methyl-ether (Gualtheria oil) is then distinctly recognised.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Chemical Manufacturers of America.—We should be obliged if any correspondent could give us the name and the publisher's address of a good Directory of the chemical manufacturers, brokers, and drysalters of the United States of America.—T. H. A.

MEETINGS FOR THE WEEK.

Monday, 4th.—Royal Institution, 5. General Monthly Meeting.
— Society of Chemical Industry, 8. "Modes of Using Char," by Messrs. B. E. and J. R. Newlands. "Olive Oil and its Adulterations," by Mr. T. T. P. Bruce Warren.
Tuesday, 5th.—Royal Institution, 3. "Conventions and Conventionality in Art," by Sidney Colvin, M.A.
Wednesday, 6th.—Geological, 8.
Thursday, 7th.—Royal Institution, 3. "The Growth and Sculpture of the Alps," by Professor T. G. Bonney, D.Sc., LL.D., F.R.S., &c.
— Chemical, 8. Ballot for the Election of Fellows. "The Chemical Action of some Micro-organisms," by R. Warington, F.R.S. "The Optical and Chemical Properties of Caoutchouc," by J. H. Gladstone, F.R.S., and W. Hibbert.
Friday, 8th.—Astronomical, 8.
— Quekett Club, 8.
— Royal Institution, 9. "Phosphorescence and Ozone," by Professor Dewar, M.A., F.R.S.
Saturday, 9th.—Royal Institution, 3. "Count Tolstoi as Novelist and Thinker," by Professor C. E. Turner.
— Physical, 3. "On the Analogy between Gases and Substances in Dilute Solution," by Prof. J. H. van 't Hoff, communicated by Prof. W. Ramsay. Exhibition of a Lantern, by Mr. W. Lant Carpenter.

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THE CHEMICAL NEWS.

Vol. LVII. No. 1489.

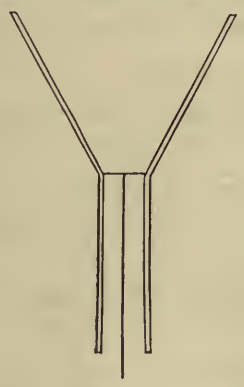
NOTE ON A FUNNEL FOR FILTERING CARBON.

By THOMAS M. DROWN, M.D

The essential feature of the unnel, as illustrated in the accompanying sketch, is the cylindrical stem; the external diameter of which should be a trifle smaller than the internal diameter of the porcelain tube into which the carbon is ultimately transferred for combustion. This stem, in the funnels used in the analytical laboratory of the Institute, has a diameter of half an inch, the porcelain tubes being five-eighths of an inch diameter internally.

To support the asbestos which retains the carbon, a flat coil of rather heavy platinum wire is used, one end of which extends from the centre of the coil to a little below the end of the stem, as shown in section in the drawing.

The asbestos, which should be well broken up, but still fibrous, is, while suspended in water, poured on to the coil, when the funnel is connected with the suction-pump. It is desirable to have the funnel at least one-fourth full of asbestos. If a suction-pump is not available, a loose mass of asbestos fibre may be used, which fills the funnel about one-half or two-thirds full.



When the carbon is all on the filter and completely washed, the particles adhering to the sides of the funnel are removed by rubbing with a little moist asbestos held in forceps, and this asbestos is put on top of the carbon.

The coil of wire is now taken out of the funnel by pulling on the vertical wire in the stem, and the funnel is set aside to dry.

When ready for combustion, the stem of the funnel is inserted into one end of a porcelain tube, which contains near its other end a layer of copper oxide, retained in place by plugs of asbestos. The transference of the asbestos and carbon to the tube is very simply and completely effected by means of a glass rod. Any particles of carbon adhering to the glass are easily removed by gentle friction with asbestos. The mass of asbestos and carbon are thrust well into the middle of the tube, and the sides of the tube are freed from any particles of carbon by pushing down several light plugs of asbestos.

The advantages of this form of funnel are, first, that the cylindrical stem permits the asbestos to be immediately transferred to the tube without loss; and, second, that the wide upper portion of the funnel allows the liquid containing the carbon to be poured rapidly and freely.

Platinum tubes and boats are often used for filtering off carbon, and the great advantage in their use consists in the fact that they can be directly inserted into the porcelain tube without removal of their contents. But this advantage is accompanied by the drawback that they present but little surface for filtering, and the liquid containing the carbon must, consequently, be poured on to the asbestos very slowly, and with great caution. Where a large number of funnels are required, the expense of the platinum is also worth considering.

A copper-wire coil may be used in cases where it would not be dissolved. In filtering the acid solution of cupric chloride in the determination of total carbon in iron, I have used a moderately heavy copper wire, which, although somewhat attacked, retains sufficient strength to support the asbestos to the end of the operation.

A variation in the usual method of carbon determinations in iron and steel has been successfully tried with this funnel. The iron borings have been placed directly on the asbestos filter, and the solution of the cupric-ammonium chloride has been passed over it by means of a syphon, delivering about a drop a second.

From 100 c.c. to 150 c.c. of a nearly saturated solution of the double chloride is sufficient to dissolve all the iron, so that the residue on the filter, which contains some metallic copper, may be washed with dilute hydrochloric acid. It is washed finally with water, dried, transferred to the combustion tube, and burned in oxygen without regard to the presence of any metallic copper which may be present.

The direct decomposition of iron by the double chloride in a glass tube in which the combustion is subsequently made, would seem to be a still more perfect method of determination of carbon, since it involves no transfer at all. But the advantage in the use of a porcelain tube for the combustion is so great, on account of its being unaffected by the sudden application of heat, and by the highest temperature of the combustion furnace, that it is worth while to take a little more time to transfer the carbon—time which is fully compensated for in the greater ease and security in conducting the combustion.—*Technology Quarterly*, May, 1888.

THE SOLUBLE ACTION OF ROCHELLE SALT ON THE METALLIC HYDRATES.

By H. N. WARREN, Research Analyst.

The general solvent action that a tartrate such as Rochelle salt possesses towards the metallic hydrates and carbonates is—for instance, in the case of the ferric and cupric compounds—too well known to need further description. But on a comparison being made with the other compounds of a similar class, or group, a marked assimilation is observed. Not only does the solvent action of Rochelle salt predominate over the ferric and like compounds, but also to an equal extent over the ferrous, dissolving them with great facility, forming a deep green solution; and it is also exercised to a similar extent over the hydrated precipitates of zinc, manganese, nickel, cobalt, iron, chromium, and aluminium; even the precipitates of compounds of barium, strontium, calcium, and magnesium are to a considerable extent soluble when boiled with a concentrated solution of the Rochelle salt.

Owing to the ready manner in which antimony oxychloride is dissolved by this salt, I have several times observed lecturers, when demonstrating or instructing beginners, advise the use of this compound as a reagent for determining whether the precipitate formed is one of antimony or bismuth, or whether both are in admixture: this is, however, entirely erroneous, and is apt to lead a beginner widely astray, since both compounds are entirely dissolved on adding a sufficient quantity and heating.

The same compound is not uncommonly used when a quick method is required to distinguish between a precipitate supposed to be either one of antimony or tin; notwithstanding the entire list of stannic compounds are almost as readily soluble in a solution of this reagent as are the antimonic precipitates.

An exception to this rule appears to exist in the case of cadmium carbonate, which is practically insoluble in a neutral tartrate solution, such as is afforded by a solution of Rochelle salt. Cadmium salts, when in solution, may by suitable means by this compound be therefore separated from those of the cupric, those of the latter being, as are well known, soluble in excess of that salt.

I have not as yet fully experimented with respect to the solvent action of Rochelle salt on the rarer earths,—zirconia, glucina, &c.,—but am of opinion that it may possibly open an easy means of separating such oxides when in the hydrated condition.

Everton Research Laboratory,
18, Albion Street, Everton, Liverpool.

RESEARCHES ON ALLOISOMERISM.*
I.

By ARTHUR MICHAEL.

(Concluded from p. 215).

Behaviour of Citraconic Acid towards some other Aromatic Primary Amines.

It seemed to be of interest to ascertain whether other primary aromatic amines than aniline would show similar reactions with citraconic acid, and to what degree the basic property of the amine could be decreased without its losing the power of giving the anilide reaction.

A solution of acid paratoluidine citraconate in five parts of water gives, on warming, a crystalline precipitate that melts at 161°, and when crystallised from absolute alcohol melted at 166°. This compound is probably the acid toluide. When it is crystallised several times from boiling water it is converted into a different substance, which is the tolil.

0·3670 grm. substance gave 0·9625 grm. CO_2 and 0·1885 grm. H_2O.

0·3631 grm. substance gave 0·9552 grm. CO_2 and 0·1815 grm. H_2O.

	Theory for $CH_3-\underset{\underset{CH-CO}{\vert}}{C}-CO\!>\!N-C_6H_4-CH_3$.		Found.
C	71·64	71·50	71·71
H	5·46	5·69	5·56

Citracontolil crystallises from water in long silky needles that melt at 114·5°. It is insoluble in dilute chlorhydric acid and alkalies, soluble in alcohol and hot water, sparingly soluble in cold water.

Mono-ortho-toluidine citraconate dissolves readily in cold water. This solution becomes turbid on boiling, and if the heating is continued for about half an hour an oil separates. On cooling, a further quantity of oil was deposited, that on standing gradually became solid. It was insoluble in dilute chlorhydric acid, and was evidently a toluidide.

α-Naphthylamine citraconate in aqueous solution gives an oily precipitate on boiling, which solidifies on standing. The compound crystallises from alcohol as yellow plates that melt at 141° and may be sublimed unchanged. The compound is insoluble in dilute chlorhydric acid and alkalies, and probably represents citracon-naphthylimide.

A solution of β-naphthylamine citraconate also deposits a substance on boiling. This compound, crystallised from water, forms yellow feathery needles that melt at 170° and may be sublimed without change. It is insoluble in dilute chlorhydric acid.

The behaviour of metamido-benzoic acid towards citraconic acid is of particular interest, as this substance is so weak a base that it does not form salts with monobasic organic acids. A solution of one part of citraconic acid in five of water dissolves metamido-benzoic acid (equivalent proportions) very slowly in the cold, rapidly on warming. When this solution is boiled a crystalline precipitate is soon deposited, which was purified by crystallisation from hot water.

0·3802 grm. substance gave 0·8710 grm. CO_2 and 0·1366 grm. H_2O.

	Theory for $CH_3-\underset{\underset{CH-CO}{\vert}}{C}-CO\!>\!N-C_6H_4.COOH$.	Found.
C	62·33	62·46
H	3·89	4·00

Meta-citraconanil-carboxylic acid crystallises from water as fine prismatic needles that melt at 218°. It is soluble in hot alcohol and water, sparingly soluble in cold water, and insoluble in dilute chlorhydric acid. Dilute solutions of alkalies dissolve it to form salts.

Although it did not seem likely that citraconic acid would form an anilide with sulphanilic acid, as this amido compound does not even form salts with mineral acids, an experiment was made that gave negative results. Corresponding to the anilides, derivatives of phenylhydrazine have been obtained by using analogous methods. Our expectation that phenylhydrazine would form an azide on heating with aqueous citraconic acid was fulfilled. A solution of monophenylhydrazine citraconate in ten parts of water, when boiled, turns yellow, and a crystalline precipitate soon separates, which is considerably increased as the solution cools. It was purified by crystallisation from alcohol.

0·3903 grm. substance gave 0·9441 grm. CO_2 and 0·1851 grm. H_2O.

	Theory for $CH_3-\underset{\underset{CH-CO}{\vert}}{C}-CO\!>\!N_2HC_6H_5$.	Found.
C	65·34	65·89
H	4·95	5·24

It crystallises in long bright yellow prismatic needles that melt at 160°, and are sparingly soluble in cold, pretty soluble in hot water, and readily in hot alcohol. It is insoluble in dilute chlorhydric acid. As citraconic acid does not form anilides with secondary amines, the reaction is very likely correctly expressed by the following equation:—

$$CH_3-\underset{\underset{CH-COOH}{\vert}}{C}-COON_2H_4C_6H_5 = CH_3-\underset{\underset{CH-CO}{\vert}}{C}-CO\!>\!N-NH-C_6H_5+2H_2O.$$

Behaviour of Phthalic Acids towards Aniline.

The phthalic acids are distinguished by the capability of the ortho acid of forming an anhydride. All attempts to obtain a similar derivative of the other two acids have been futile. As the ease that polybasic acids form anhydrides evidently is in close relationship with the anilide reaction, and ortho-phthalic acid forms its anhydride with readiness, it seemed of interest to examine whether this reaction would not serve to distinguish between these isomeric acids.

The acid aniline phthalate is difficultly soluble in cold, but dissolves readily in hot water. If a solution of this salt in six parts of water is boiled in a flask connected with a cooler, it will be noticed that a precipitate gradually separates from the hot solution, that increases as the solution cools. The acid aniline salt is readily decomposed by dilute chlorhydric acid, forming the chlorhydrate and free acid, while the precipitate formed by boiling a solution of the salt is insoluble in that acid.

* *American Chemical Journal*, Vol. ix. No. 3.

It melts at 203°, and agrees in all its properties with phthalanil. The anil is also formed by boiling an aqueous solution of the neutral aniline salt, and when a solution of the acid salt is allowed to stand at ordinary temperature for some days.

Isophthalic acid also forms an acid aniline salt, but its solution in water may be boiled for hours without anything separating from it, and on cooling yields unchanged salt that is readily soluble in dilute chlorhydric acid. An aqueous solution of the neutral aniline salt gave the same result.

Terephthalic acid unites with aniline, but with difficulty, and the salt is unstable in presence of considerable water. A solution in a small quantity of hot water was boiled for an hour without any change taking place, and a like result was obtained by heating an aqueous solution of the neutral salt.*

Behaviour of some Saturated Polybasic Acids towards Aniline.

It seemed desirable to show that the property of forming anilides on heating an aqueous solution of aniline salts is characteristic of a certain group of unsaturated acids, and not shown by polybasic saturated fatty acids. We shall make but a brief mention of our experiments in this direction, and include in it several experiments with unsaturated acids. Acid aniline oxalate is difficultly soluble in hot water. After boiling its aqueous solution for a long time, long flat prisms separate on cooling. They are soluble in dilute chlorhydric acid, and consist of unchanged salt.

Acid aniline malonate dissolves readily in cold water. Its solution undergoes no change on boiling.

Acid aniline succinate is difficultly soluble in cold water, but dissolves in hot. It undergoes no change when its aqueous solution is boiled.

One part of tartaric acid in ten parts of water will dissolve sufficient aniline to form the acid salt. On boiling this solution a precipitate separates. This, however, represents an aniline tartrate, as it is immediately decomposed by dilute chlorhydric acid.

Acid aniline citrate is soluble in cold water, and does not change when its aqueous solution is boiled.

Acid aniline camphorate dissolves in boiling water, and after cooling separates unchanged as an oil that gradually solidifies.

Acid aniline pyrotartrate (obtained by reducing citraconic acid) is soluble in hot water, and undergoes no change when its aqueous solution is boiled.

Acid and neutral aniline mucates do not form anilides when their aqueous solutions are boiled.

Summary.

I. Unsaturated polybasic organic acids may be divided into two classes according as their aniline salts, in aqueous solution, split off water to form anilides or remain unchanged. The anilide-forming acids are classified as belonging to the maleic acid series, and the others to the fumaric acid series.

II. Of the acids as yet examined the following belong to the maleic series: maleic, brommaleic (m. pt. 128°), dibrommaleic acid (123°), citraconic, itaconic, bromcitraconic, aconitic, and orthophthalic acids. To the fumaric series: fumaric, bromfumaric (178°), chlorfumaric (191°), mesaconic, mucic, camphoric, and iso- and terephthalic acids.

III. Chlor- and bromfumaric acids, in aqueous solution, when boiled with aniline are converted into the anil of phenyl-amidomaleic acid.

IV. The bromine atoms of dibrommaleic acid are symmetrically grouped.

V. The acids of the maleic series give the anilide reaction with all primary salt-forming aromatic amines, but not with secondary or tertiary aromatic bases. On this property a method of separating these bases has been based.

VI. The acetates of primary amido-benzenes are not decomposed by cold water, while those of the secondary or tertiary amines, if formed at all, are decomposed. A separation of basic mixtures has been based on these properties.

VII. Saturated polybasic acids do not give the anilide reaction.*

VIII. The results obtained in this investigation cannot be brought in harmony with the hypothesis that acids of the maleic series contain a divalent carbon.

IX. The anhydride and anilide formation of orthophthalic and similar acids probably depends on their belonging to the maleic series, and not on the positions of the carboxyls as represented by the constitutional formulæ now in use.

X. Aqueous solutions of the citraconates of fatty amines do not form alkylamides.

* There is no doubt but that a very convenient method or detecting the presence of carboxyls in ortho position in aromatic acids can be based on their forming anilides from aqueous solutions of their aniline salts. The existence of a second orthophthalic acid that would stand in the same relation to orthophthalic acid that fumaric does to maleic acid also seems probable

* This rule is certainly not without exceptions, as experiments with the aniline salts of the dibenzyldicarboxylic acids have shown, which will be published later. The behaviour of aniline salts of polybasic organic acids in their aqueous solution will be continued, and I wish to reserve the further examination of the reaction until my research is completed.

PROFESSOR SCHORLEMMER, LL.D., F.R.S.

A Complimentary Dinner was given on May 25th at the Queen's Hotel, Manchester, to Prof. Schorlemmer, of the Owens College, by his former pupils, to inaugurate the occasion of the conferring of the degree of LL.D. upon him by the Senate of the Glasgow University and to offer their congratulations.

In the absence of Sir Henry E. Roscoe, M.P., who had been expected to be present and to act as chairman, one of Prof. Schorlemmer's eldest pupils or friends, Mr. R. S. Dale, took the chair.

Amongst those who accepted the invitation were S. R. Platt, Esq., J.P., of Oldham; A. M'Dougall, Esq.; W. J. Hurst, Esq.; Prof. T. E. Thorpe, Ph.D., F.R.S., of the Normal School of Science, South Kensington; Prof. Dreschfeld; Prof. A. Smithells, of the Yorkshire College, Leeds; Prof. W. C. Williams, of Firth College, Sheffield; Francis Jones, Esq., F.R.S.E., of the Manchester Grammar School; Prof. P. P. Bedson, of the Newcastle College of Physical Science; Dr. C. A. Kohn, of University College, Liverpool; Dr. J. B. Cohen, of the Owens College; Messrs. Hermann Woolley, H. Baker, H. Grimshaw, W. H. Darling, L. T. O'Shea, Hindle, and J. Hulme. Dr. G. H. Bailey and Mr. Watson Smith, of the Owens College, together with the Chairman, formed the committee of management, and in response to their invitation the following friends of Prof. Schorlemmer were present:—Prof. Dixon, F.R.S., of the Owens College; Dr. Edward Schunck, F.R.S.; Dr. Gerland; Ivan Levinstein, Esq.; Dr. J. Grossmann; L. Siebold, Esq.; R. F. Gwyther; J. B. Millar, Esq., and others.

Numerous congratulatory letters and telegrams were received by Dr. Schorlemmer, both from this country and from the Continent, and early in the evening a letter was read from Sir Henry Roscoe, M.P., regretting that he would not be present, and testifying to the high appreciation and regard he felt for the ability and talents of his old friend and colleague, as well as for his personal qualities. Sir Henry claimed that just as Sir Humphry Davy discovered Faraday, so he, with the aid of Prof. Dittmar, discovered Schorlemmer, in that home of so many great German chemists, Darmstadt. Telegrams of congratulatory import were then read from Dr. Pauli, director of the firm of Meister, Lucius, and Brüning, in Hoechst;

and from Prof. Bernthsen, of the Badische Anilin und Sodafabrik, in Ludwigshafen; and, finally, a very warm and highly eulogistic letter from Prof. Hermann Kopp, of Heidelberg, the great historian of chemistry, bearing testimony to the eminent position Schorlemmer has attained as one of the principal pioneers of the science of organic chemistry and one of its first exponents, both as a teacher and a writer.

Prof. Thorpe proposed the health, long life, and prosperity of Dr. Schorlemmer, and referred to the fact that Glasgow, which had thus conferred honour on Prof. Schorlemmer, had given rise to men such as Black and Thomson, names familiar to all chemists.

Prof. Dixon expressed the hope that he might have the pleasure and advantage of working for many years yet to come with such a colleague as Prof. Schorlemmer, and adding the regret that he had not enjoyed the privilege shared by so many around him of having been one of his pupils.

It may be interesting to note that it is principally to Schorlemmer's researches in the laboratory of the old Owens College in Quay Street that the science of chemistry owes the present system and orderly arrangement of the formerly obscure but very extensive and important branch of the paraffins and their alcoholic and acid derivatives. His researches into the constituents of American petroleum and the demonstration of the true constitution of those components, the paraffins, form classic ground. The isolation of the pure colouring-matter aurin and the preparation of a series of its derivatives, with the final triumph in the shape of the transformation of aurin into pararosaniline, a research carried out in conjunction with his friend and the chairman of the evening, R. S. Dale, are achievements forming a chapter in organic chemistry of which the chemical department of the Owens College may be justly proud. These and many other researches Schorlemmer in bye-gone years has shared with his pupils, and we are quite sure that a reunion such as took place on this occasion was not only a source of pleasure to their honoured guest himself, but served to recall agreeable memories of a connection with Owens College extending now over thirty years.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Anniversary Meeting, March 28th, 1888.

Address of the President, William Crookes, F.R.S.*

(Concluded from p. 217).

We now come to the last objection pertinently set forth by Clerk-Maxwell to the hypothesis that the elements are not absolutely homogeneous. He writes:—"It is difficult to conceive of selection and elimination of intermediate varieties, for where can these eliminated molecules have gone to if, as we have reason to believe, the hydrogen, &c., of the fixed stars is composed of molecules identical in all respects with our own?"

In the first place we may call in question this absolute molecular identity, since we have hitherto had no means for coming to a conclusion save the means furnished by the spectroscope, whilst it is admitted that for accurately comparing and discriminating the spectra of two bodies they should be examined under identical states of temperature, pressure, and all other physical conditions. We have certainly seen, in the spectrum of the sun, rays which we have not been able to identify.

We have supposed the cosmic cycle re-entering in successive periods, during a fall of temperature, the same region—say, for instance, where chlorine, bromine, or iodine have been formed. If most of the atoms present approximate more or less closely to 35·5, 80, or 127—the atomic weights of these three bodies—they will be in consequence easily disposed of. But there may be besides a few intermediate atoms having, say atomic weights of between 36 and 79 and between 81 and 126. These atoms will be attracted to the masses on one side or the other of the cyclical track. We can even imagine sparse atoms scattered so far from the centre line of track as to be midway between chlorine and bromine or between bromine and iodine; these wanderers likewise will be slowly picked up and will gravitate to chlorine, bromine, or iodine; and, being thus accounted for, none need be eliminated.

It is not impossible, moreover, that the elementary atoms themselves are not the same now as when first generated. For if an atom has commenced its existence at a certain epoch, and may go through such vicissitudes that it will cease to exist, it seems at least probable that it may undergo inward change. These vicissitudes probably directly affect only the primary motions which constitute the existence of the atom, but they indirectly, and only in a slight degree, affect those secondary motions which produce all the effects we can observe—chemical effects, heat effects, electrical, and so on. Thus, while the life of an atom may be waning away under the various experiences to which it is subjected, it may, and probably does, appear to us the same as at first. But perhaps not quite, so that atoms originally alike, taken from different minerals collected at widely separated stations on the earth, *may* have had sufficiently different past histories to have come to be markedly different in regard to the primary motions which elude our observation, and through the very slight influence which changes in the primary motions have on the secondary motions, *may* be just perceptibly different under our experiments. From this point of view a rare element, like a rare plant or animal, is one which has failed to develop in harmony with its surroundings.

This view lends itself very naturally to the facts we encounter in our fractionation experiments. Where all the ultimate atoms have precisely identical rates of vibration, any fractionation is impossible. Where such rates are not identical the process proves successful; and all the more easily the wider the differences among the vibration-rates of the ultimate atoms. The bodies thus split off necessarily very closely approximate to each other, and the further we push our fractionations the less marked are the differences.

But as we review the series of elements arranged on the curve I adopted from Professor Emerson Reynolds to illustrate my address on the "Genesis of the Elements," delivered before the Chemical Section of the British Association (Birmingham Meeting), we cannot fail to be struck by a consideration which at first sight appears absolutely fatal to the notion of the production of the elements from a series of "knots," as just described. If the element which we call aluminium has been formed from ultimate atoms having rates of vibration of the rate 27, or a little more or less, so as to give a mean of 27, and if the atoms between aluminium and the next element in the series have in this manner been sorted out to the one hand or the other, leaving a void between, we should expect that their properties would not differ very widely from each other, or at least that they would present considerable analogies. Now to a certain extent this is actually the case. Upon aluminium follows silicon. We may perhaps conceive these two elements as springing from the differentiation of a nearly homogeneous swarm of ultimate atoms. But if we pursue the curve onwards, what elements follow? Phosphorus, sulphur, and chlorine, bodies heterologous with each other and heterologous with silicon. We can scarcely imagine original atoms, so to speak, in doubt which of two aggregations they should join

* From the *Journal of the Chemical Society* for May, 1888.

the one being silicon and the other phosphorus. Nor can we conceive of anything being split off from sulphur which should make even the slightest approximation to chlorine.

It appears to me, however, that these difficulties are more apparent than real. In the Birmingham Address already referred to, I asked my audience to picture the action of two forces on the original protyle, one being *time*, accompanied by a lowering of temperature; the other, swinging to and fro like a mighty pendulum, having periodic cycles of ebb and swell, rest and activity, being intimately connected with the imponderable matter, essence, or source of energy we call *electricity*. Now a simile like this effects its object if it fixes in the mind the particular fact it is intended to emphasize, but it must not be expected necessarily to run parallel with all the facts. Besides the ebb and flow of temperature with the periodic ebb and flow of electricity, positive or negative, requisite to confer on the newly born elements their particular atomicity, it is evident that a third factor must be taken nto account. Nature does not act on a flat plane; she demands space for her cosmogenic operations, and if we introduce *space* as the third factor all appears clear.

Instead of a pendulum, which though to a certain extent a good illustration is impossible as a fact, let us seek some more satisfactory way of representing what I conceive may have taken place. Let us suppose the zigzag diagram not drawn upon a plane, but projected in space of three dimensions. What figure can we best select to meet all the conditions involved?

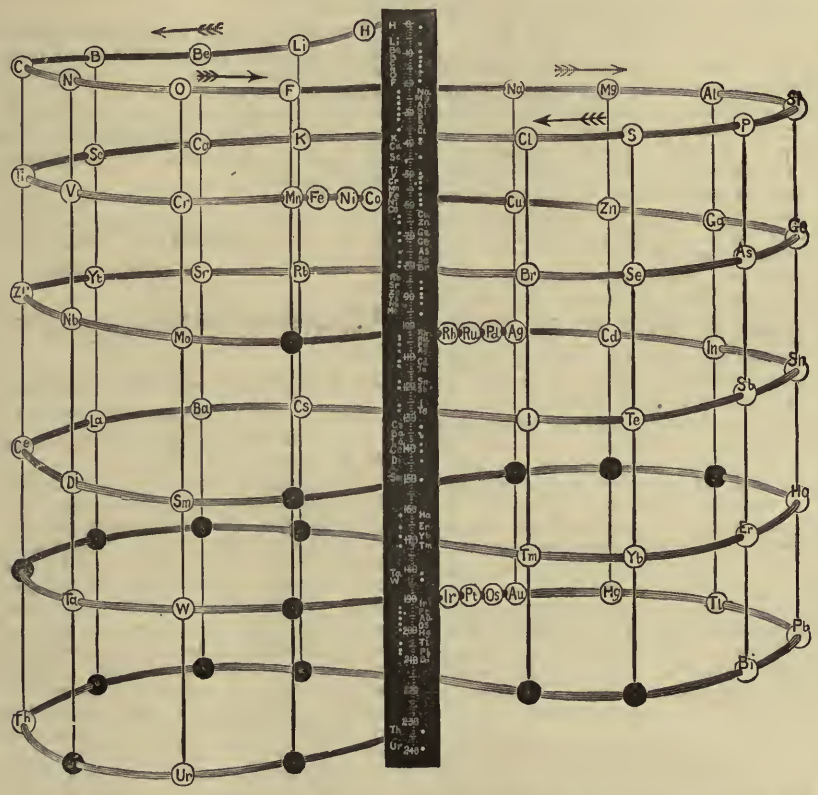
Many of the facts can be well explained by supposing the projection in space of Professor Emerson Reynolds's zigzag curve to be a spiral. This figure is, however, inadmissible, inasmuch as the curve has to pass through a point neutral as to electricity and chemical energy twice in each cycle. We must therefore adopt some other figure. A figure of eight or lemniscate will foreshorten into a zigzag just as well as a spiral, and it fulfils every condition of the problem. Such a figure will result from three very simple simultaneous motions. First, a simple oscillation backwards and forwards (suppose east and west); secondly, a simple oscillation at right angles to the former (suppose north and south), of half the periodic time, *i.e.*, twice as fast; and thirdly, a motion at right angles to these two (suppose downwards), which, in its simplest form, would be with unvarying velocity.*

If we project this figure in space we find on examination that the points of the curves where chlorine, bromine, and iodine are formed come close under each other; so also will sulphur, selenium, and tellurium; again, phosphorus, arsenic, and antimony, and in like manner other series of analogous bodies.

It may be asked whether this scheme explains *how* and *why* the elements appear in this order? Let us imagine a cyclical translation in space, each revolution witnessing the genesis of the group of elements which I previously represented as produced during one complete vibration of the pendulum. Let us suppose that one cycle has thus been completed, the centre of the unknown creative force in its mighty journey through space having scattered along its track the primitive atoms, the seeds, if I may use the expression, which presently are to coalesce and develop into the groupings now known as lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, sodium, magnesium, aluminium, silicon, phosphorus, sulphur, and chlorine.

What is most probably the form of track now pursued? Were it strictly confined to the same plane of tempera-

Fig. 2.



* Put into their simplest mathematical dress, the first of these motions is represented by $x=a.\sin(mt)$, the second by $y=b.\sin(2mt)$, and the third by $z=c.t$.

ture and time, the next elementary groupings to appear would again have been those of lithium, and the original cycle would have been eternally repeated, producing again and again the same fourteen elements. The conditions, however, are not quite the same. Space and electricity are as at first; but temperature has altered, and thus, instead of the atoms of lithium being supplemented with atoms in all respects analogous with themselves, the atomic groupings which come into being when the second cycle commences form not lithium but its lineal descendant, potassium.

Suppose, therefore, the *vis generatrix* travelling to and fro in cycles along a lemniscate path as above suggested, while simultaneously temperature is declining and time is flowing on (variations which I have endeavoured to represent by the downward sink); each coil of the lemniscate track crosses the same vertical line at lower and lower points. Projected in space, the curve shows a central line neutral as far as electricity is concerned, and neutral in chemical properties—positive electricity on the north, negative on the south. Dominant atomicities are governed by the distance east and west from the neutral centre line, monatomic elements being one remove from it, diatomic two removes, and so on.*

In every successive coil the same law holds good. As the mighty focus of creative energy goes round we see it in successive cycles sowing in one tract of space seeds of lithium, potassium, rubidium, and cæsium; in another tract, chlorine, bromine, and iodine; in a third, sodium, copper, silver, and gold; in a fourth, sulphur, selenium, and tellurium; in a fifth, beryllium, calcium, strontium, and barium; in a sixth, magnesium, zinc, cadmium, and mercury; in a seventh, phosphorus, arsenic, antimony, and bismuth; in other tracts, aluminium, gallium, indium, and thallium; silicon, germanium, and tin; carbon, titanium, and zirconium; whilst a natural position near the neutral axis is found for the three groups of elements relegated by Professor Mendeléeff to a sort of hospital for incurables—his 8th family.

We have now traced the formation of the chemical elements from knots and voids in a primitive, formless fluid. We have shown the possibility, nay, the probability, that the atoms are not eternal in existence, but share with all other created beings the attributes of decay and death. We have shown, from arguments drawn from the chemical laboratory, that in matter which has responded to every test of an element, there are minute shades of difference which may admit of selection. We have seen that the time-honoured distinction between elements and compounds no longer keeps pace with the developments of chemical science, but must be modified to include a vast array of intermediate bodies—"meta-elements." We have shown how the objections of Clerk-Maxwell, weighty as they are, may be met; and, finally, we have adduced reasons for believing that primitive matter was formed by the act of a generative force, throwing off at intervals of time atoms endowed with varying quantities of primitive forms of energy.

If we may hazard any conjectures as to the source of energy embodied in a chemical atom, we may, I think, premise that the heat radiations propagated outwards through the ether from the ponderable matter of the universe, by some process of nature not yet known to us, are transformed at the confines of the universe into the primary — the essential — motions of chemical atoms, which, the instant they are formed, gravitate inwards, and thus restore to the universe the energy which otherwise would be lost to it through radiant heat. If this conjecture be well founded, Sir William Thomson's startling prediction of the final decrepitude of the universe through the dissipation of its energy falls to the ground.

In this fashion, gentlemen, it seems to me that the great question of the elements may be provisionally treated. Our slender knowledge of these first mysteries is extending steadily, surely, though slowly. Whilst certain ardent chemists are testing the commonly received view of the homogeneity of the elements by methods of fractionation, others, by means of the spectroscope, are carrying on another form of assault; each worker bent on the one idea of undermining the secret. I earnestly recommend such researches. However successfully pursued, they cannot, I know, lead directly to any results capable of being turned to industrial account. If, however, we consider the small but firm foothold we have gained in pursuit of this line of investigation, I venture to think there is reasonable ground to hope that these researches may tend to place chemistry upon a new foundation, by penetrating down through loose superficial matter to the solid rock.

The application of the luminous principle of evolution has re-modelled and vivified many branches of biology; and philosophers are eagerly invoking its aid in other departments of science; I would fain hope that I may not be deemed unduly sanguine in believing that the application of this regenerating principle to chemistry will produce far-reaching effects on its harmonious and progressive development.

* In the model curve, Fig. 2, the elements are supposed to follow one another at equal distances along the lemniscate spiral. The vertical scale is divided into 240 equal parts, on which the atomic weights are plotted, from H=1 to Ur=239. Each ball representing an element is accurately on a level with its atomic weight on the vertical scale. Metallic elements are silvered; it will be seen that with one or two exceptions all the metals are on the north side. Missing elements are represented black. A few doubtful elements—didymium, samarium, erbium, holmium, and thulium,—are inserted in the positions required by the atomic weights usually assigned to them; a glance, however, will show that they have no right to the places they occupy.

PHYSICAL SOCIETY.

May 26th, 1888.

Mr. Shelford Bidwell, F.R.S., Vice-President, in the Chair.

Mr. S. O. Roberts was elected a member of the Society.

The following communications were read:—

"*Note on the Governing of Electromotors.*" By Profs. W. E. Ayrton and J. Perry.

In a paper read before the Society of Telegraph Engineers in 1882 the authors deduced the conditions of self-regulation of electromotors for varying load when supplied either at constant potential or with constant current. The conditions involved "differential winding," *i.e.*, the use of a shunt motor with series demagnetising coils. With this arrangement fairly good regulation has been obtained, but owing to want of economy the methods have not been developed further. Since then another arrangement, in which a simple shunt motor is used and a few accumulators placed in series with the armature, has been devised for working in a constant current system. By means of a suitable switch the accumulators can be charged when the motor is at rest. On the assumption that the E.M.F. of motors is given by $E = n(p+tZ)$, where n = speed, Z = number of turns on magnets, and p and t are constants, it is shown that the speed at which a motor will govern is given by—

$$n = \frac{z+a+a'}{t}$$

and the constant current—

$$C = \frac{e-np}{a+a'}$$

where z and a are the resistances of the shunt and armature respectively, and e and a' the E.M.F. and resistance of the accumulators. Since a and a' may be small and np not large, the value of e need not be great to give a considerable value for C, and thus only a small number of accumulators will be required.

"*On the Formula of Bernoulli and Haecker for the Lifting-power of Magnets.*" By Prof. S. P. THOMPSON, D.Sc. Read by Prof. PERRY.

The formulæ referred to are $P \alpha \sqrt[3]{W^4}$ and $P = a \sqrt[3]{W^2}$ respectively, where P = lifting-power, W = mass of magnet, and a a constant depending on the material and shape of the magnet. These formulæ the author shows are equivalent to saying that that the lifting-power of magnets in which the magnetic induction, B, has been carried to an equal degree, is proportional to the polar surface, and that Haecker's coefficient, a, is proportional to B^2 through the surface. Assuming the induction uniform over the surface it is shown that—

$$P = \frac{1}{8\pi} B^2 A$$

where A = area of surface, and this gives a very convenient method of determining B from measurements made upon the pull exerted at a given polar surface. If P be measured in kilos. and A in sq. c.ms. the formula for B becomes—

$$B = 5000 \sqrt{\frac{P}{A}}$$

and if the measurements be made in lbs. and inches the constant becomes 1317.

It will be readily seen that the greater power of small magnets in proportion to weight does not require for its explanation the sometimes alleged fact that small pieces of steel can be more highly magnetised than large ones, for if B be the same, the lifting-power will be proportional to the polar surface, and not to weight, and hence must necessarily be greater relatively to weight in small magnets. In the case of electromagnets for inductions between 6000 and 16000, between which the permeability, μ, is approximately given by—

$$\mu = \frac{16000 - B}{3 \cdot 2}$$

the lifting power is shown to be—

$$P = A\left(\frac{3 \cdot 2\, Si}{Si + 2 \cdot 56\, l}\right)^2$$

where P is in kilos, A in square centimetres, Si = ampere turns, and l = mean length of the magnetic circuit.

"*Experiments on Electrolysis. Part* II. : *Irreciprocal Conduction.*"* By Mr. W. W. HALDANE GEE, B.Sc., and Mr. H. HOLDEN, B.Sc.

An abstract was read by the Secretary.

The authors have observed, when strong sulphuric acid is used as an electrolyte, the electrodes being of platinum, that the decomposition nearly ceases if, by decreasing the resistance in circuit, it is attempted to increase the current beyond a certain maximum. When this condition (called the insulating condition) is arrived at, reversing the current immediately restores the conductivity. Experiment shows that the current density is an important factor, and that the composition, viscosity, and temperature of the electrolyte, as well as the previous history of the electrodes, have considerable influence on the current density at which the insulating condition occurs. The seat of the insulating layer is found to be at the anode, and the authors believe it due to very concentrated acid formed around the electrode, whose specific resistance is very high. Experiments were also made with carbon and gold electrodes, and phosphoric acid, caustic potash, soap, and sodium benzoate were used as electrolytes, the results of which seem compatible with the concentration hypotheses above stated.

The paper contains an historical and critical account of allied phenomena, and tables expressing the numerical results obtained by the authors are given.

* Irreciprocal conduction is said to occur if a reversal of the direction of a current causes any change in its magnitude.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, June 4, 1888.

His Grace THE DUKE OF NORTHUMBERLAND, K.G., D.C.L., LL.D., President, in the Chair.

THE following were elected Members of the Royal Institution :—

F. W. Bayley, F.C.S., Jacob Feis, Charles Albert Flint, Arthur Holland, Mrs. John Mackinlay, and Thomas Woolner, R.A.

The special thanks of the Members were returned to Professor W. Chandler Roberts-Austen, for his present of a Portable Assay Furnace.

The presents received since the last meeting were laid on the table, and the thanks of the Members returned for the same.

NOTICES OF BOOKS.

Nature's Hygiene : A Systematic Manual of Natural Hygiene, containing a Detailed Account of the Chemistry of Eucalyptus, Pine, and Camphor Forests and Industries connected therewith. By C. T. KINGZETT, F.I.C., F.C.S. Third Edition. London : Baillière, Tindall, and Cox.

THE preface to this third edition of Mr. Kingzett's work contains a passage which deserves the most careful attention. Says the author, justly and pertinently :—"While the development of chemical science in recent years has been most marked, sanitary authorities have not sufficiently availed themselves of its services, but have relied much too confidently upon mere engineering skill. The disposal of the London sewage as at present effected will serve to exemplify my meaning, and may be taken by way of illustrating the disastrous results that may ensue from such an unfortunate reliance. The water-carriage system of sewage has grown in London from a blessing into an unmitigated and terribly costly evil."

This passage, it may be said, gives the key-note to that part of the work before us which discusses general sanitation. Thus, in considering the great question of water-supply, he does not accept the sweeping dictum of the River Commissioners that "Rivers which have received sewage, even if that sewage has been purified before its discharge, are not safe sources of potable water." He examines the evidence of Dr. Tidy, Prof. Odling, Dr. Pehl, Mr. Sorby, and Dr. Hogg, and he disposes very fairly of the so-called "Caterham case." He quotes also the important experiment conducted by Mr. Crookes and Drs. Odling and Tidy, which showed that the germs of splenic fever, after eighteen hours' of contact with large volumes of water, become incapable of propagation. He considers it necessary, however, that no untreated sewage should be allowed to enter the Thames.

He notes the absence of paper in the sewage at the London outfalls and refers to its comminution. That it is so comminuted and that it forms a sparingly pervious layer on the surface of filter-beds and sewage-fields is no "theory" devised by Dr. Tidy or by any one else, but a fact which has been known for years to persons practically conversant with the treatment of sewage.

The attempts to deodorise the Thames by the addition of chloride of lime and potassium permanganate he considers futile, the cost being stupendous and the effect far too little.

Having condemned the system of sewage disposal as carried out in London, and that with good grounds, he turns to irrigation. He admits that "given suitable ground, of sufficient extent, and in dry weather we can by irrigation very completely purify sewage." But he holds, very justly, that we have not a sufficiency of land available

for this purpose, whence irrigation cannot be accepted as "an exclusive means of purifying sewage."

Precipitation processes are judged very fairly, though we cannot accept without questioning the opinion that the cost of the chemicals employed is much greater than the increased value given to the product.

Into the remainder of this valuable book we cannot here enter. But we must venture to ask why do sanitarians confine their attention to the so-called zymotic diseases? Is it not true that the diseases of debility, phthisis, albuminuria, affections of the heart and brain, which are always active in our midst, are largely caused by human folly, and are therefore preventible? But we are doubtful as to the reception which might fall to the lot of the author or lecturer who should point out some of the causes of these affections. Mr. Kingzett's work, meantime, deserves our warm commendation, and we are glad that the present edition has been found necessary.

Merchandise Marks Act, 1887: Being an Act to Consolidate and Amend the Law on Fraudulent Trade-Marks. A Complete Digest of its Sections, with Definitions thereof. By H. C. Richards, Barrister-at-Law, and Henry Smith (Messrs. Stapley and Smith), together with the Regulations made by the Commissioners of Customs, &c., &c. Reprinted from the *Warehousemen and Drapers' Trade Journal*. London: *Warehousemen and Drapers' Trade Journal* Office.

The necessity for the Act here discussed is very generally admitted, save by the very persons whose doings it was intended to repress. We understand that goods manufactured abroad have been systematically branded with the names and trade-marks of well-known British firms, and sold as of British make not merely in neutral markets, but even in this country. It is even said that with the obvious purpose of bringing British manufacturers into discredit such trade-marks have been attached to very inferior articles. We are told that the name "Sheffield" has been bestowed upon a new suburb of a foreign manufacturing town in order that cutlery made there might, with technical truth, be warranted as of "Sheffield make." To interfere with such practices in neutral markets is, of course, beyond the power of Government; but so far as the United Kingdom is concerned, the present Act seems likely to have a wholesome effect. That such will be the case seems probable from the outcry raised against it in certain quarters, but we do not see that it can occasion any hardship to the honest trader.

The work treats of offences under the Act, of penalties and methods of procedure, of the nature of trade-marks and trade descriptions. Further sections deal with forged marks, exemptions, watch marks, evidence, accessories, search warrants, limitations as to prosecutions, imported goods, and royal warrants.

The bulk of the treatise is taken up with a digest of the Act, in which explanatory matter is interposed. As far as we can judge the authors will have rendered no small service to traders who wish to conform with the provisions of the law as it now stands.

Journal of the Royal Agricultural Society of England. Part I. of Vol. xxiv. April, 1888.

Among the memoirs here comprised we notice one by Mr. R. Valentin, on the "Practical Value of Dung as compared with Artificial Manures." The author combats the still existing prejudice in favour of dung and against chemical manures. He declares that dung, even when containing a good percentage of nitrogen, due to costly feeding-stuff, seldom shows such favourable results in the crops as artificial manures, which contain their nitrogen in a more readily available form. Chemical manures have hitherto, he admits, produced crops of both corn and roots fully better than dung. In making dung from dear food and applying it to the land there is a considerable loss. The residue left after assisting one crop suffers loss from the rains in winter.

The "Report of the Consulting Entomologist," Miss E. A. Ormerod, F.E.S., F.R. Met. S., though of great value, can scarcely be said to fall within our scope. Much the same holds good concerning the "Report of the Consulting Botanist," Mr. W. Carruthers, F.R.S., P.L.S., who shows that farmers are imposed upon to no small extent by the adulteration of seeds.

The Consulting Chemist, Dr. J. A. Voelcker, has been much engaged with spurious feeding cakes. He points out that the favourite material used by sophisticators is rape-refuse, *i.e.*, rape-seed from which the oil has been withdrawn not by pressure but by solvents. This fraud is not to be detected with certainty by chemical means. In a sample thus adulterated to the extent of 30 per cent there is no one point upon which the chemist can rely as conveying definite evidence of the fraud. Hence careful systematic examination with the microscope becomes necessary. In addition to rape linseed cake may contain cockle-seed, mill-sweepings, niger-seeds, locust beans, and hemp-seed.

Cotton-seed cake appears to have fallen off in quality, so far as its most valuable constituent, the oil, is concerned.

Three samples of sewage sludge have been examined. One of them contained 34 per cent of sand, with 43 per cent of moisture. The specimen which Dr. Voelcker designates as the best contained 10·82 per cent of sand, 45·45 of moisture, and 24·43 of carbonate of lime. Such products will do little to raise the reputation of sewage manures. The experiments tried with basic slag have been inconclusive, owing to the dryness of the season.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of emperature are Centigrade unless otherwise expressed

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Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 21, May 22, 1888.

The Part played by Nitrogen in Vegetable Economy.—E. Chevreul.—The author points out that as far back as 1854 M. Georges Ville announced the same views on the fixation of nitrogen by plants as those which have been subsequently published by MM. Gautier and Drouin. In 1854 a Commission composed of MM. Dumas, Regnault, Decaisne, Peligot and the author, after a series of careful experiments, decided in favour of M. Ville as against M. Boussingault.

Determination of the Combustion-heat of a New Solid Isomer of Benzene.—W. Louguinine,—The combustion-heat of this novel compound is 847,384 cals., that of normal benzene being only 776,000 cals.

The Neutralisation-heats of Cyanomalonic Ether, Acetyl-, and Benzoyl-cyanacetic Ether.—Alb. Haller and A. Guntz.—This thermo-chemical memoir does not admit of useful abstraction.

Zeitschrift fur Analytische Chemie. Vol. xxvi., Part 5.

Distinction between Citric Acid and Tartaric and Malic Acids.—Mean.—The author heats the acid with 0·7 glycerin until vapours of acrolein are evolved, takes up the mass in a little ammonia, the greater part of which is then expelled by heat. He then adds 2 drops of nitric acid (fuming acid diluted with 5 parts of water). Citric acid takes a green colour, which turns blue on heating. The two other acids do not show this reaction.

Detection of Small Quantities of Hydrocyanic Acid.—G. Vortmann.—The liquid in question is mixed with a few drops of a solution of potassium nitrite, 2 to 4 drops of solution of ferric chloride, and dilute sulphuric acid enough to turn the yellowish brown basic ferric salt first formed to a light yellow. It is then heated to incipient ebullition, mixed with a few drops of ammonia to precipitate the excess of iron, filtered, and the filtrate is tested with 1 to 2 drops of very dilute, colourless ammonium sulphide. If hydrocyanic acid was originally present the solution takes at once a violet colour, which changes into blue, green, and finally into yellow. If the quantity of hydrocyanic acid is very small, a bluish green colour is produced at once.

Cyclamose.—G. Michaud.—From the *Bulletin de la Soc. Chimique.*

Action of Potassium Permanganate upon Glucose.—A. Smolka.—Part of the sugar remains unchanged, whilst the rest is converted into water, carbon dioxide, and oxalic and acetic acids.

The Alkaloids of the Barberry.—E. Schmidt.—From the *Archiv. der Pharmacie.* No particulars are here given.

On a New Volatile Alkaloid Arecan.—E. Bombelon.—This base is obtained from the betel nut. Its hydrochlorate gives a yellow precipitate with platinum chloride, a light yellow with gold chloride, a white with mercuric chloride, and a whitish with tannin.

On Sparteine. — Grandval and Walser.— From the *Journal de Pharmacie et Chemie.*

Characteristic Reactions of Hydrastine.—A. B. Lyons.—From the *Druggists' Circular.*

On Ulexine.—A. W. Gerrard.— From the *Pharm. Journal.*

The Jodlbauer Modification of the Kjeldahl Nitrogen Process.—A. Stutzer and O. Reitmar.—Both with pure nitres and with nitriferous manures the authors obtained results accurate to within a few hundredths of a per cent by attending to the following points. The nitrate or the nitriferous manure must be submitted to the action of the phenol-sulphuric acid in a very fine state of division. They weigh out 1 grm. of the nitriferous manure, cover it with 25 c.c. of water, and evaporate it down at 100° to 110°. To the dried mass they add 50 c.c. of a sulphuric acid containing, per litre, 20 grms. phenol, let it stand for some minutes with occasional agitation, add 2 to 3 grms. zinc powder free from nitre, and 1 to 2 drops of mercury, and heat to a boil. In an hour and a half the conversion into ammonium sulphate is complete.

Volumetric Determination of Alkaloids with Mayer's Reagent (Potassium-mercury Iodide).— F. S. Hereth.—Fifty c.c. of the solution of the extract are mixed with acidulated water and cautiously evaporated at a gentle heat to drive off alcohol. Any matter deposited is filtered off and the filter is washed with acidulated water. The liquid, which should contain about 1 per cent of free sulphuric acid, is made up to 100 c.c. Eight portions of 10 c.c. each are measured into test-tubes with a pipette, and the quantity of Mayer's liquid required for 10 c.c. is determined by a preliminary experiment on the rest of the liquid. Supposing that this is about 3 c.c., we add to the respective portions 2·7, 2·8, 2·9, 3, 3·1, 3·2, 3·3, and 3·4 c.c. each, let them stand, closed for eight hours, pour the supernatant liquid into eprouvettes, and add to each 0·1 c.c. of the Mayer solution. In one to two minutes it can be seen in which portion no further deposition takes place.

Determination of Tartaric Acid in Wine Lyes.—V. Olivier.—From the *Bulletin de la Société Chimique.*

Determination of Inverted Sugar in Crude Sugar.—F. Wolf.—From the *Zucker Industrie.* The method approximates to that of Patterson and Biggart.

Cider and Apple Vinegar.—W. F. Smith.—From the *Journal of the American Chemical Society.*

Chemical Reaction for Cholera Bacteria.— Odo Bujwid.—When the colonies are grown up to small white points, such a point is placed in beef-broth and cultivated for twelve hours at 37°. If cholera bacilli are present the liquid, on the addition of 5 to 10 per cent of ordinary hydrochloric acid, takes a faint rose-violet colour.

Detection of "Wild Mace" or "Bombay Mace" in Ground Mace.—R. Frühling.—From the *Chemiker Zeitung.*

Determination of Carbon Disulphide in Benzol and Crude Naphthol.—Ph. Holland and Harcourt Phillips.—From the *Journal of the Society of Chemical Industry.*

Detection of Mineral Oils in Pine Oil.—Finkener.—The author treats the sample in question with 10 vols. of a mixture of 10 vols. alcohol (sp. gr. 0·8182 at 15·5°) and 1 vol. chloroform. Pure pine oils dissolve in this mixture, whilst mineral oils do not dissolve even in 100 vols.

Analysis of Explosives.—G. Lunge.—This paper requires the accompanying figure.

Examination of Commercial Quinine Sulphate.—A bulky article taken in great part from the *Pharmaceutical Journal*, the *Journal de Pharmacie*, the *Chemist and Druggist*, and the Chemical News.

Detection of Peptone in Blood.—Georges gives two processes, the first proposed by Wassermann and the second by Tanret.

Detection of Carbon Monoxide in Blood.—According to Gruber the method of Fodor gives good results if the blood be taken in hand at once, but after some hours it does not succeed, as the carbon monoxide is oxidised by the oxy-hæmoglobine.

Detection of Mercury in Urine and Animal Liquids. A. Almén.—The author proposes a modification of the process of Reinsch.

The Reducing Substances in Diabetic Urine.—The figures found by titration point to a higher proportion of sugar than those found by polarisation or by fermentation.

A Novel Pathological Pigment in Urine. — W. Leube.—This pigment was found in the urine of an osteomalacic subject. It dissolves in ether with a reddish violet colour. It shows no characteristic absorption-band.

The Spectral Behaviour of Certain Colouring-matters Physiologically and Clinically Interesting.—C. Crukenberg.—An examination of the spectra of the blue and red colouring-matters obtained from tilirubine, the spectra of hydrocyanic-oxyhæmatine, hæmatoporphyrine, and other animal colours. The details are not given.

Detection of Blood-pigment in Urine.—L. Lewin and C. Posner.—In bloody urine the spectral detection of methæmoglobine and hæmatine is practicable only in such thick strata that the entire spectrum is extinguished up to the red.

MISCELLANEOUS.

Hofmann Testimonial Fund.—We are informed by Mr. J. Spiller, Hon. Sec. for Great Britain, that the sum total subscribed in the United Kingdom towards the Hofmann Testimonial amounted to £256 8s. 6d.: which, after deducting the expenses of printing and postage, and retaining until now a small balance for contingencies, was transmitted to Berlin on the 31st March, by the Chairman, Sir Frederick Abel. We give below a translation of the letter of acknowledgment which Professor von Hofmann has addressed to Dr. C. A. Martius, secretary of the central committee, expressing his deep sense of gratitude to all the subscribers for the honour paid him in the celebration of his 70th birthday, and indicating the nature of the application which he proposes should be made of the

fund which has been collected. The Emperor of Germany has conferred upon Professor Hofmann the rank of Privy Councillor and a title of nobility, and both the Empress of Germany and Her Majesty Queen Victoria joined in offering congratulations on the occasion of his birthday. His Highness the Comte de Paris headed our subscription list with a donation of £20, and the contributions sent in from many foreign countries attest to the wide-spread appreciation of the movement, and the desire to do honour to the Professor. Details with respect to the disposal of the money are given in the accompanying letter.

(*Translation*).

"Berlin, May 18th, 1888.

"Dear Sir,—Allow me in the first place to repeat in writing the expression of the deep sense of gratitude, which I have already verbally conveyed to you and your friends on the occasion of your presenting me with the splendid marble bust from Schaper's hand, and with the artistic address announcing the intention of creating a Hofmann Foundation. May I ask you to act as my interpreter towards those who generously combined with you to impart so auspicious a character to the celebration of my 70th birthday. I am naturally anxious to let the subscribers to the foundation know how I think the abundant means placed at our disposal should be made use of. First of all, you will permit me to make up the amount to 50,000 marks from my own resources. The interest of this sum I propose to apply to the advancement of experimental research in chemistry. I am at present occupied with the working out of a statute regulating the mode of this application, and hope before long to acquaint you with its tenour. Two important principles which will be embodied in it may, however, be mentioned even now:—(1.) It must remain with the council of the German Chemical Society to decide in each case how this advancement may best be realised. (2.) This advancement, whatever form it may take, must be free from any limitation of a national character. As soon as the statute for the foundation shall be in a measure elaborated, I propose to lay it before the council of the German Chemical Society, and after arriving at an understanding with them, I shall submit it to you, so that before it receives its final form the opinions of those may be heard by whose efforts the foundation has been created.—Accept, dear Sir, the expression of my grateful regards, and believe me, yours very sincerely, (signed) A. W. Hofmann.—To the President of the Committee for the Establishment of a Hofmann Foundation, Dr. C. A. Martius, Berlin."

NOTES AND QUERIES.

Zinc Chloride.—I should feel obliged if any correspondent could inform me if zinc chloride is used commercially in large quantities, and in what manufacture or manufactories it is used.—Q. R. V.

History of Chemistry as Known to the Ancients.—Will any correspondent kindly supply name of any English or foreign publications which treat upon chemical knowledge derived from Greek and Latin, Babylonian, Jewish, Scandinavian or Icelandic, Gothic, Persian, Arabian, and Ancient American authorities, even Assyrian Tablets, and the Chinese and cognate nationalities? Reference thereto would no doubt assist the undersigned very much.—Gertrude Amburger.

Alcohol in Water.—I am one of those unfortunate individuals who does not file his Chemical News, and consequently frequently finds himself inconvenienced accordingly. Some two years ago I read a report of some experiments on alcohol in natural waters in this journal, I believe by Dr. Dupré, showing that natural waters contain a minute trace of alcohol. Could any of your correspondents inform me of the number in which it appeared, or whether it is published in book or pamphlet form?—Delph.

MEETINGS FOR THE WEEK.

Tuesday, 12th.—Royal Medical and Chirurgical, 8.30.
—— Photographic, 8.
Wednesday, 13th.—Microscopical, 8.
Thursday, 14th.—Mathematical, 8.
—— Royal, 4.30.
Saturday, 16th.—Royal Institution, 3. "Count Tolstoi as Novelist and Thinker," by Professor C. E. Turner.

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THE CHEMICAL NEWS.

Vol. LVII. No. 1490.

THE CONDITIONS OF THE EVOLUTION OF GASES FROM HOMOGENEOUS LIQUIDS.*

By V. H. VELEY, M.A., University College, Oxford.

This paper is conveniently divided into three parts. In part (i.) an account is given of the effect of finely divided particles on the rate of evolution of gases resulting from chemical changes; in part (ii.) the phenomenon of initial acceleration, as also the effect of variation of pressure on the evolution of gases, is discussed; in part (iii.) the case of the decomposition of formic acid into carbonic oxide and water is investigated under constant conditions, other than those of the mass of reacting substances and of temperature.

Part I.—It is found that the addition of finely divided chemically inert particles increases the rate of evolution of gases from liquids in which they are being formed. The effect of these particles on the following chemical changes is investigated: (i.) the decomposition of formic acid yielding carbonic oxide; (ii.) the decomposition of ammonium nitrite in aqueous solution yielding nitrogen; (iii.) the reduction of nitric acid into nitric oxide by means of ferrous sulphate; (iv.) the decomposition of ammonium nitrate in a state of fusion producing nitrous oxide; and (v.) the decomposition of potassium chlorate in a state of fusion producing oxygen. The finely divided substances used are pumice, silica, graphite, precipitated barium sulphate, and glass-dust.

Part II.—It is observed that, conditions of temperature remaining the same, the rate of evolution of a gas from a liquid is at first slow, then gradually increases until it reaches a maximum and for some time constant rate. From this point the rate decreases proportionally to the diminution of mass. This is observed in the cases of the decomposition of formic acid, potassium ferrocyanide, and of oxalic acid by concentrated sulphuric acid, and in that of ammonium nitrate. It has previously been observed in the case of the decomposition of ammonium nitrite in aqueous solution. The same phenomenon repeats itself when the temperature is temporarily lowered and then raised to its former point, and also to a more marked degree when, temperature remaining the same, the superincumbent pressure is suddenly increased.

The reduction of pressure from one to a fraction of an atmosphere produces no *permanent* effect on the rate of evolution of a gas from a liquid; a decrease of pressure, however, produces *temporarily* an increase in the rate, and an increase of pressure conversely produces *temporarily* a decrease in the rate.

Part III.—The case of the decomposition of formic acid into carbonic oxide and water by diluted sulphuric acid is studied with the aid of an apparatus by means of which the temperature is kept constant within one-twentieth of a degree. It is shown that the rate of evolution of carbonic oxide is expressible by the following equation:—

$$\log (\tau + t) + \log r = \log c,$$

in which τ is the time from the commencement of the observations; t is the interval of time from the moment of commencement, and that at which, conditions remaining the same, the interval of time required for unit change would have been *nil*; r is the mass at the end of each observation, and c is a constant. The results calculated by this hypothesis agree with those observed, whether the interval of time required for unit change is thirty or nine hundred and sixty minutes. The curve expressing the rate of chemical change in terms of mass is thus hyperbolic and illustrative of the law—

$$\frac{dr}{d\tau} = -\frac{r^2}{c},$$

which expresses the rate at which equivalent masses act upon another; $1/c$ in each experiment is the amount of each unit mass which reacts with the other per unit of time, when a unit mass of each substance is present. Since then equivalent masses take part in the change, it is reasonable to suppose that at first an anhydride of formic acid is produced thus:—

$$\left.\begin{matrix}HCO\\H\end{matrix}\right\}O + \left.\begin{matrix}HCO\\H\end{matrix}\right\}O = \left.\begin{matrix}HCO\\HCO\end{matrix}\right\}O + H_2O.$$

The anhydride is unstable, and is subsequently decomposed into carbonic oxide and water,

$$\left.\begin{matrix}HCO\\HCO\end{matrix}\right\}O = 2CO + OH_2.$$

The change may thus be compared to the production of ethyl formate from formic acid and alcohol,

$$\left.\begin{matrix}HCO\\H\end{matrix}\right\}O + \left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}O = \left.\begin{matrix}HCO\\C_2H_5\end{matrix}\right\}O + H_2O,$$

with which it shows several points of analogy.

In the original paper the methods of observation and the apparatus used are described in full, and the results obtained are set forth in a series of tables.

* Abstract of a Paper read before the Royal Society, May 31st, 1888.

VOLUMETRIC DETERMINATION OF BROMINE.

By JOHN TSAWOO WHITE.

Bromine is evolved on heating a bromide with potassium permanganate and aluminium sulphate. Chlorides and iodides do not give off chlorine or iodine. Solutions of potassium chloride, bromide, and iodide were prepared, and their strengths determined by silver solution.

The solution, mixed with 1 grm. permanganate and 5 c.c. of a solution of aluminium sulphate saturated at ordinary temperatures, is diluted to about 50 c.c. in the distilling flask. The bromine is distilled in a current of carbon dioxide into a solution of potassium iodide, and the liberated iodine is determined by decinormal thiosulphate.

Only five-eighths of the bromine is given off, so that the bromine found × 1·6 will give the total bromine. The factor 1·6 obtained from the present experiments might be done away with or modified by future experiments. A re-distillation after 30 hours of the remainder of the solution of the fourth experiment gave but a trace of bromine. Trials of the mixed solutions were made to notice any modifying action. The results are as below. The atomic weights used in calculations are those given in Roscoe and Schorlemmer's treatise.

Taken.	Found.
0·0031 Br	0·0028 Br
0·0157 Br	0·0152 Br
0·0315 Br	0·0307 Br
0·0621 Br	0·0616 Br
0·0315 Br + 0·0229 I + 0·0439 Cl	0·0307 Br
0·0031 Br + 0·1145 I	0·0028 Br
0·0031 Br + 0·0439 Cl	0·0028 Br

Whatever the reaction is that takes place, the results are evidently constant.

Rangoon College, May 14, 1888.

Professor Williamson.—The portrait of Professor Williamson which is to be presented to University College is, we understand, to be painted by the Hon. J. Collier.

NOTES ON THE ROCK-SALT MINES OF PETITE ANSE, LOUISIANA.

By H. CARRINGTON BOLTON, Ph.D.

(Abstract).*

The southern coast of Louisiana, west of the Mississippi River, is indented by several bays through which the waters of innumerable bayous pass into the Gulf of Mexico. Near the head of one of these bays, known as Vermilion Bay, there is a nearly circular island of about 2500 acres in extent, which rises above the low marshes of the vicinity to the height of 180 feet, forming a notable feature in the monotonous landscape. This is the well known island of Petite Anse, also called Avery's Island after its present owners, in which occurs a remarkable deposit of rock-salt. Petite Anse is now easily reached by rail, *via* the Southern Pacific Railroad, from New Orleans as far as New Iberia (about 125 miles), and thence, by a branch road, 10 miles long, to the salt mine. Cotton and sugar plantations, uncultivated fields, marshes, cornfields, and cypress swamps alternate with luxurious forests of live-oak, gum, hickory, black walnut, cypress, maple, and magnolia. About two-thirds of the island are under cultivation, the most profitable crops being sugar, salt, and Tobasco pepper-sauce. Three ranges of hills can be traced, the surface water from which has cut its way deeply through the alluvial deposits, forming ravines, which, with ponds, forests, and cultivated fields, make the island a picturesque oasis in a wilderness of marsh and cypress swamps.

The existence of salt on this island has been known for a very long time, as shown by the fragments of pottery, arrow-heads, and basket work found mixed with bones of the mastodon, buffalo, and deer, unearthed in recent excavations. The written history of the deposit begins with 1791, when John Hays found a brine spring while hunting. In the last century, salt was made by boiling down the brine, and between the years 1812 and 1815 the amount produced was large. It then ceased for a time. Later, Judge D. D. Avery became owner of the island, and at the outbreak of the rebellion renewed operations on a large scale; the blockade made the salt exceedingly valuable, so that one time a bag of salt was exchanged for a bale of cotton. On May 4th, 1862, Mr. John Marsh Avery attempted to deepen a brine pit, and struck rock-salt at a depth of 16 to 17 feet below the surface. The Confederate Government then instituted mining by means of pits, and, 400 to 600 men being constantly employed, the island was a scene of prodigious activity. The Northern troops, however, seized the island April 20th, 1863, and put a stop to the industry. During these eleven months, about 22 million pounds of salt are estimated to have been taken out, the average price being 4½ cents per pound.

The first scientific observer who visited the deposit after these events was Professor Richard Owen in November, 1865 (*Am. Journ. Science*, July, 1866, p. 120). In 1866, Professor Charles A. Goessmann visited the place on behalf of the American Bureau of Mines ("Report of the American Bureau of Mines on the Rock-salt Deposit of Petite Anse," 4to., New York, 1867), and one year later it was examined by Professor E. W. Hilgard of the Geological Survey (*Am. Journ. Science*, Jan., 1869, and "Mineral Resources of the United States," Albert Williams, Jr., Washington, 1883).

To the reports of these gentlemen we owe some of the particulars of this notice.

The rock-salt lies only fifteen to twenty feet beneath the surface. The surface soil is a dark loam, beneath which occur layers of coarse and fine sand, gravel, and clay, all irregularly stratified and in no definite direction. The salt itself occurs as a massive crystalline rock of a saccharoidal texture, dry, hard, and homogeneous. It is of a white colour, except in streaks or bands two to six inches in width, which are quite black. The salt appears to have a uniform character in all parts of the mine, and is remarkable for its purity, especially in its freedom from calcium and magnesium salts. It is also quite free from potassium salts; for traces of Stassfurt salts I made especial search in vain. The following analyses show the great purity of this product:—

	Analysis by Mr. F. W. Taylor, (Smithsonian Institution), March, 1882.	Analysis by E. W. Hilgard. 1863.
Sodium chloride	98·731	99·880
Calcium sulphate	1·192	0·126
Calcium chloride	trace	trace
Magnesium chloride ..	0·013	
Silica	0·024	100·006
Iron sesquioxide	0·010	
Water	0·030	
	100·000	

Other analyses made by Professor Goessmann range from 98·88 to 99·60. It is of interest to compare this with rock-salt from other localities.

	Cheshire.	Stassfurt.	Berchtesgaden.
Sodium chloride	98·30	94·57	99·85
Potassium chloride ..	—	—	trace
Calcium chloride	—	—	trace
Magnesium chloride ..	0·05	0·97	0·15
Calcium sulphate	1·65	0·89	—
Insoluble	—	3·35	—
Water	—	0·22	—
	100·00	100·00	100·00

Partial analyses of the black salt have been made by Mr. McCalla, the resident engineer and chemist, who finds that it yields a white solution and about seven per cent of a white insoluble residue, chiefly gypsum. The black colour, therefore, seems to be an optical phenomenon. These black bands form well-marked folds in the salt, the space between the ridges and above them being filled with coarser granules of salt than the rest. Near these black bands the finest cleavage crystals of transparent purity are found. These bands seem to indicate that at some time the rock mass has been subjected to lateral pressure, causing ridges.

The geological features of the island and the origin of the salt deposit have been discussed by both Professor Goessmann and Professor Hilgard. The former thinks it is "probably of tertiary age," and says, "many circumstances favour the theory that the deposit is a secondary one—resulting from the evaporation of brine springs, originating from beds of rock-salt in some older geological formation—and not a direct residuum of the sea. This explains the entire absence of intercalations of gypsum and the absence of potassium and magnesium compounds."

Professor Hilgard thinks it should be assigned to the cretaceous, since there is "no phase of the tertiary history of the Gulf of Mexico that seems to admit of" the conditions required, viz., the long-continued evaporation of some very large body of sea-water. He calls attention to the banded structure of the rock-salt, and remarks that the "Stassfurt salts" belonging to the salt mass have long ago been washed into the general ocean.

We would call the attention of geologists to two facts which may throw light on the questions: the occurrence on the island of bedded sandstone and of lignite. The sandstone is exposed at the bottom of a deep ravine about 1500 feet from the shaft, the rock is of a light grey colour and contains little or no calcite. It is distinctly seen to be in place, and is weathered to a considerable depth beneath the surface. At the base of another ravine, formed

*Read before the New York Academy of Sciences, Feb. 13th, 1888. From *Transactions of the New York Academy of Sciences*, vol. vii.

by a rivulet cutting through the alluvium, gravel, and sand, and at a distance of about 2000 feet from the shaft, there is an outcrop of lignite. The latter is apparently several feet in width and of good quality for economic purposes. Mr. McCalla reports that it contains fifteen per cent of ash. Both the sandstone and the lignite seem to dip in such a direction (S.E.) as would cause them to run beneath the salt. This view is also confirmed by some of the borings. Indications of fossil plants occur in the brown coal, but at the time of my visit it was unfortunately impracticable to dig deeply into it, and I had to be content with a mere surface specimen.

There are four other islands stretching along the coast in the vicinity, but borings have failed to reveal salt on any of them.

The mine is now worked by a system of chambers and cross-headings. The single shaft has reached a depth of 166 feet (including the sump of 6 feet). The old workings at a depth of 90 feet have been abandoned, owing to the infiltration from above of water carrying with it clay and sand, which rendered the salt impure. The lower level is at a depth of 160 feet. The extent of the excavation in the upper level is about 8 acres, and the extreme ends of the galleries are 900 feet apart. The excavation on the lower level is much smaller. The method of operating is to run galleries about 6 to 8 feet high, and then to work upward to a height of 40 feet, leaving between the galleries large pillars to support the roof. The boring is done with a kind of auger of a German pattern, imported in deference to the prejudices of the workmen, who are largely Stassfurt miners. The auger is worked by hand and penetrates the salt one inch for every twelve revolutions of the bit. The blasting is done with dynamite, of which 80 to 100 boxes, each containing 100 lbs., are used every month, say on an average 150 lbs. daily.

After blasting down 40 feet the salt is broken by sledges, placed in small hand carts, and hoisted on a platform to the surface by steam power. About one hundred men are employed by the company, of whom fifty work below the surface. They work on ten-hours time.

The rock mass is quite dry, but, owing to bad management in the early history of the mine, water from the surface runs into it through seams and openings; to remove this two pumps, capable of throwing out 100 gallons per minute, are run about ten hours out of the twenty-four. The brine pumped out is allowed to waste.

Ventilation is necessitated by the great quantity of dynamite exploded daily. Air is supplied by a fan 8 feet in diameter, 4 feet wide, driven at about 250 revolutions per minute. This, it is estimated, supplies about 600,000 cubic feet of air per hour.

Pockets of an inflammable gas have been repeatedly struck, and on a recent occasion the issuing gas was lit and burnt for an hour or more. Perhaps this phenomenon is connected with the underlying lignite.

The engines used for running the blower, the fan, reels, breakers, &c., are three in number, and aggregate 250 horse-power.

The salt brought to the surface is crushed between corrugated rollers driven at high speed; one set breaks it into lumps from two to three inches in diameter, and another into lumps one-half inch in diameter and finer. It is then ground into various grades by six buhr-stone mills, each capable of grinding 50 tons in ten hours. The salt is sorted by jigs, revolving reels, and blowers, the fine dust being blown out by a horizontal current of air striking against a column of falling salt.

The salt is sent into market in eight grades:—(1) Rock-salt in lumps from 100 to 300 pounds, used by farmers, it being placed under sheds for cattle to lick. (2) Crushed salt that passes over ½-inch screens and through ¾-inch screens. (3) "Fish salt," including all which passes through a ½-inch screen. (4) Coarse ground. (5) Medium ground. (6) Fine ground. (7) For sack and barrel salt the coarser particles of grade 6 are screened out with a wire screen of ten meshes to the inch, and the fine dust is blown out. (8) The fine dust thus blown out divides itself by gravity into an impalpable part (which is thrown away, being a small percentage) and a coarser part, which forms table salt. The salt is shipped to market in sacks and barrels.

For the year ending July, 1887, the product was 44,000 tons. In a busy season the daily shipments run as high as 300 tons. Formerly the material was transported by water, through a canal expressly maintained for the purpose, into the bay, some miles distant; now the railway carries it exclusively.

The amount of salt in sight is very great, and the possible extent of the deposit is enormous. Borings show that about 142 acres of ground are underlaid with salt, the extreme depth of which has not been ascertained, though borings have been sunk 190 feet. Everywhere the character of the salt is the same, and the mine is evidently destined to supply the market for generations to come. At present the owners of the property have leased the mining privilege for a consideration to the American Salt Company.

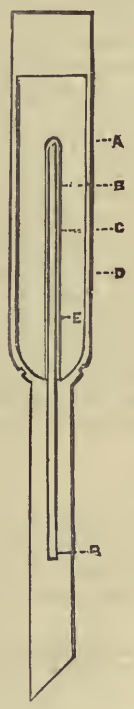
[Specimens of sandstone, lignite, and salt were exhibited, the latter in transparent cleavage crystals, some of which measured 4×3×2 inches.]

Dr. Bolton expressed his obligations to Capt. Hascall for hospitality, and to the Messrs. Avery for courtesies during his visit. He also desired to thank Mr. McCalla for kind attentions and valued information.

A NEW EXTRACTION APPARATUS.

By C. M. KING.

The apparatus about to be described has been devised to overcome certain defects of the otherwise excellent "Soxhlet" tube in general use: these are (1) spasmodic



action of the syphon and (2) consequent flow of the extracting liquid in channels; (3) its somewhat complex form, and therefore high price. The annexed figure represents a

section of the apparatus drawn to scale. A is a wide test-tube; B, a quill tube sealed into the bottom of A, its upper end being cut off at an angle as shown; C is a tube of somewhat greater diameter inverted over B, resting on its apex and reaching nearly to the bottom of A. The outer tube, D, is so constructed below that A rests upon the projections shown; the narrow portion below passes through the cork of the flask containing the extracting liquid; the upper end is fitted with a cork through which passes an upright condensing tube with or without water-jacket, according to circumstances.

The substance to be exhausted is placed in the space between A and C, resting on a plug of glass-wool below. It is advisable to tie the plug to C at E, and thus form a support for the substance and a clear liquid space below. The liquid being brought to the boil, rises for the most part in the space between A and D, is condensed above, and flows upon the substance. the level rising in A and simultaneously in the space between B and C, until the apex of B is reached. It then flows down this quill tube, and through the intervention of C the whole of the liquid is syphoned from A into the boiling flask beneath.

This syphon is the essential point of the apparatus. Its action is characterised by automatic regularity.*

Laboratory of Messrs. Cross and Bevan,
4, New Court, W.C.

NOTE ON THE SOLUBITY OF CALCIUM COMPOUNDS.

By ALFRED H. ALLEN.

In their paper on "The Influence of Temperature on the Composition and Solubility of Hydrated Calcium Sulphate and of Calcium Hydroxide," recently read before the Chemical Society, and published in the June number of the *Chem. Soc. Journ.* (vol. liii., p. 544), Messrs. Shenstone and Cundall express some surprise that the solubility should be less in hot water than in cold.

I believe it has not been previously pointed out—or if it has the fact receives no recognition in the article on "Calcium" in the new edition of Watts's "Dictionary of Chemistry"—that this peculiar property of diminished solubility with increase of temperature is possessed by many calcium compounds. Thus it is not only true of the sulphate and hydroxide, but also of the acetate, propionate, normal butyrate, normal valerate, iso-octate, citrate, and benzoate. I do not pretend that this is anything like a complete list of the recorded cases of the kind. The instances I quote are simply those of which I happen to have readily accessible notes; but they are sufficiently numerous to suggest that the character of diminished solubility with rise of temperature has a connection with the basic radical present, as well as with the decomposition of unstable hydrates. But now that the question has been raised it might be interesting to inquire whether there is a loss of water of hydration in the instances quoted.

Sheffield, June 9, 1888.

THE KJELDAHL PROCESS FOR THE DETERMINATION OF NITROGEN.

By E. WALLER and H. C. BOWEN.

This process was devised by Kjeldahl, of Copenhagen, for use in connection with the brewing industry. The details were first published in 1883.†

A convenient amount of the nitrogenous material (0·5 to 1 grm.) was heated in a flask with 10 c.c. concentrated sulphuric acid with addition of Nordhausen acid, or phosphoric anhydride, until the solution was nearly colourless. Pulverised potassium permanganate was then cautiously added (to complete the destruction of the organic matter), until the green colour of manganic acid appeared. After cooling and diluting an excess of caustic soda solution was added, and on distilling the nitrogen (now in the form of ammonia) was titrated in the distillate. The acid was caused to act upon the material at a temperature just short of boiling. To prevent the otherwise inevitable bumping on distilling with the soda, a few pieces of metallic zinc were added to the retort or distilling flask.

Kjeldahl found that the process, as described, failed to give all of the nitrogen as ammonia in some compounds of the fatty and aromatic series, in some alkaloids, and in nitrates, though as regards the latter, when sugar was added, a much larger proportion (60 to 80 per cent) of the nitrogen than was expected was found to be converted into ammonia.

The theory of the process is given by Dafert as follows:—

1. The acid withdraws from the material the elements of water.

2. The action of the acid upon the organic substance also affords SO_2, which acts reducing upon the nitrogenous material.

3. Where some nitrogenous compounds partially resist this action the permanganate added toward the close of the acid treatment breaks them up, forming ammonia.

Treatment with Acid.

The relative proportions of concentrated sulphuric acid, Nordhausen, and phosphoric anhydride are not specified in the original paper. The proportion of Nordhausen acid used by different experimenters is from 20 to 50 per cent. Some, as Pflüger and Bohland, Kulisch, &c., use no phosphoric anhydride. Wilfarth also regards it as unnecessary when metallic oxides are used. It is noted by Kreusler and others that Nordhausen acid frequently contains nitric acid, which may consequently give untrustworthy results.

The proportion of phosphoric anhydride used is from 10 to 25 per cent. Some (as Kreusler) use phosphoric anhydride and omit the use of Nordhausen altogether, in some cases, however, using in its stead the metallic oxides recommended by Wilfarth. Wilfarth's modification consists in the addition of about 0·1 to 0·6 grm. CuO, and 0·7 grm. HgO.

This recommendation has been further modified by the suggestion to use the anhydrous sulphates of those metals, or even metallic mercury in place of the oxide. HgO, prepared by heating the nitrate, is inadmissible in any case.

Kulisch, in experimenting on wines, found the addition of CuO to afford but little advantage in point of speed, which was one of the main points claimed by Wilfarth.

Schmitz applied Wilfarth's method successfully in the analysis of coal and coke.

Ulsch found that the operation was hastened by the addition of 5 drops of a $PtCl_4$ solution containing 0·004 grm. metallic Pt per c.c. Platinum black was unsatisfactory. Adding also 0·05 grm. CuO gave still better results. He found, however, that an excess of platinic chloride might easily cause loss of nitrogen.

Adding the acid by instalments was found to be of advantage in certain researches of C. Arnold, and of Brunemann and Seyfert. About one-fourth of the whole amount of acid was first added, and the flask gently heated until frothing had materially diminished, when the remaining three-fourths were added, and the operation conducted as usual.

It is asserted by Lenz that the size of the flask in which the operation is conducted has a material influence upon the amount of acid and of time required for effecting the

* The apparatus can be obtained of Messrs. E. Cetti, of Brook St., Holborn.

† Fresenius, *Zeit. Anal. Chem.*, xxii., 366.

decomposition. This may be the cause of the wide disagreement of different experimenters on those points.

To avoid loss by spattering, some use long slender-necked flasks, while many others use some perforated bulb stopper arrangement in the neck of the flask. Slanting the flask also is another device. Special forms of heaters, protecting the flasks by wire gauze, or using the naked flame, &c., are details which have been differently managed by different analysts.

Use of Permanganate.

Czeczetka proposes the use of a solution of the permanganate in concentrated sulphuric acid, instead of the pulverised form. Lenz, Kulisch, and some others regard the use of this reagent as a very necessary part of the operation, but C. Arnold, as well as several others, omit it as useless. With these latter, Asboth agrees only partly, stating that it is necessay in the case of difficultly decomposable substances, as morphine, &c. On the other hand, Wilfarth and some others regard its use as involving possible loss of ammonia. Many of the chemists referred to quote analyses in support of their views on this point.

Distillation.

Bumping is prevented by passing a current of steam through the solution, by Petri and Lehmann.

Asboth adds enough Rochelle salt to prevent any precipitation of metallic hydrates by the alkali. Wilfarth found that bumping occurred when soda was used, but not with potash. Scovell's experience is exactly the reverse. It is noted by many experimenters that the evolution of hydrogen when metallic zinc is added causes some of the alkali to be carried into the distillate, and to obviate this, some advise interposing wire gauze, or glass beads, &c., in the neck of the distilling flask, while others use a bulbed tube above the flask. Much of the caustic soda and potash sold for laboratory use has been purified by fusion with nitrate, and in contact with zinc this may afford enough ammonia to interfere with the correctness of the results.

When mercury or its compounds have been used in the treatment with acid (Wilfarth's process), potassium, or sodium sulphide must be added, to break up the mercur-ammonium compounds. Ulsch uses ferrous sulphate for that purpose.

Presence of Nitrates.

To *remove* nitrates when present, Warington first heats the material with ferrous sulphate and hydrochloric acid, and, after drying, proceeds as usual. Reitmair accomplishes this by heating the substance with sulphuric acid in a tin capsule, finally throwing capsule and contents into the decomposition flask. The French Association of Sugar Chemists remove the nitrates by heating for some time at 110° C. in contact with oxalic acid.

To *determine* the nitrogen in nitrates by this method, Asboth proposes the addition of about 1·7 grms. benzoic acid to every 0·5 of nitrate. Spencer and C. Arnold, however, did not obtain satisfactory results by this means, though the latter found it fairly good when larger amounts of benzoic acid were used. Jodblauer proposed the use of phenol-sulphuric acid, followed by zinc dust, the theory being that nitrophenol is at first formed, which, by the action of the zinc, is converted to an amide, and by the subsequent treatment into ammonia. Stutzer and Reitmair only find this method effective after treating the material with water and evaporating to dryness in order to distribute the nitrate through the mass in a finely-divided condition. Salicylic acid, instead of phenol, has been found by Scovell to be more advantageous. He prescribes for 0·7 to 1·4 grms. of the substance, 30 c.c. sulphuric acid, and 2 grms. of salicylic acid, followed by the gradual addition of 8 grms. of Zn dust, and then 2 or 3 drops of platinic chloride. After gentle heating until frothing ceases, and then more strongly for five or ten minutes, 0·7 grm. HgO is added, and the heating continued as usual.

General.

The process commends itself in the examination of many nitrogenous substances, on the score of expense of material and of trouble; in the matter of economy of time the statements are very diverse. It seems hardly safe, as yet, to claim for the process universal applicability. It has been noted, especially with azo- and diazo-compounds, that the treatment permits of some loss of nitrogen in the elemental state, and with some others, as those of the pyridin and chinolin group, the process seems to fail.

In using this process upon fertilisers, flour, cattle foods, and material of that nature, we have found that many of the devices recommended by other experimenters can be made unnecessary. A method found to be satisfactory is as follows:—

The substance to be examined is first tested as regards its action with concentrated sulphuric acid. Then 0·5 to 1·5 grms. of the material is weighed out in a flask of 100 to 150 c.c. capacity: the flask should have preferably a short wide neck (nearly 1 inch diameter). Enough concentrated sulphuric acid usually 5 to 12 c.c.) is then added, to maintain a liquid state of the mixture on heating. If too little acid is used a coke-like mass results, which is difficult to manage. After adding the acid, a short funnel with wide stem may be inserted in the neck. Such funnels may be easily made from glass tubing of about ⅝ths inch internal calibre. The heat is applied gently until foaming ceases, when it is gradually increased. The heating is performed on a tin plate, with or without a bit of sheet asbestos under the flask. When the condition of the contents of the flask will permit it (which is usually very soon after frothing has ceased), a clay chimney is placed about the flask, to protect it from the cooling influence of the external air. *The mouth of the flask and funnel must be below the top of the protecting chimney or guard.* It may even be well to lay a clock glass across the top of the guard, leaving of course some exit for the fumes. The flame of a good Bunsen burner may be applied, to the extent of heating the supporting plate to a cherry-red. Thus arranged, the oxidation and simultaneous evaporation of the sulphuric acid proceeds very rapidly. The heating is kept up until the contents of the flask are reduced to about 2 c.c. Under the conditions described this will take about an hour. Ordinarily the solution is then quite colourless; at times it has a pale reddish tint, and sometimes, though rarely, the reddish tint is deeper. In the latter case 2 to 3 c.c. of Nordhausen acid are added, and it is heated as before.

After obtaining a solution which is nearly or quite colourless, the contents of the flask are allowed to cool before adding the permanganate (in powder). After adding this reagent, gentle warming will cause it to exert its effect. Now evaporate down to about 1·5 c.c., cool, dilute with water to about 150 c.c., and transfer to an Erlenmeyer flask of about 250 c.c. capacity, having a doubly perforated stopper. Through one hole passes a bulbed exit tube leading to the condenser, through the other a stopcock funnel tube, the end of which reaches nearly to the bottom of the flask. Through the latter a solution of caustic soda or potash is introduced, in sufficient quantity to give a decided precipitate of manganous hydrate. The distillation can then be effected without difficulty. The end of the condenser is allowed to dip into water containing a known amount of standard acid, which is titrated back as usual, after distilling off about one-half of the contents of the flask.

The principal advantages of this mode of management consist in a marked saving of time and increased effectiveness of the sulphuric acid, thus dispensing for ordinary work with any addition of phosphoric anhydride, metallic oxides, &c. Moreover, by driving off much of the excess of acid, and exercising reasonable care in the neutralisation of the remainder, the distillation can be effected without danger from the bumping of the solution.

We have not investigated as to how far it may be

possible to omit altogether the use of the permanganate, though it seems probable that in many cases it might be dispensed with.

In the Table below are some of the results obtained, as compared with the Ruffle and absolute methods. The results on sodic nitrate and fertilisers containing nitrate are only given as confirmatory of the failure of the method to give trustworthy results without modification. With pure nitrate a considerable quantity of sugar was used. The Ruffle method also fails in presence of nitrates.

	Kjeldahl.	Ruffle.	Absolute.	Theory.
Urea	46·662	—	—	46·754
„	46·620	—	—	46·754
„	46·816	—	—	46·754
„	46·704	—	—	46·754
Impure ammonia sulphate	20·42	20·70	—	21·21
Sodic nitrate	4·49	11·64	16·6	16·47
Cotton-seed meal	6·20	6·30	6·37	—
„ hulls	0·448	—	—	—
Fertiliser	2·72	2·42	2·74	—
„	2·26	2·33	2·25	—
„ containing nitrate	1·18	2·00	2·40	—
„ „	1·93	2·36	2·44	—
„ „	3·44	4·06	4·51	—

It may also be added that the students in the Quantitative Laboratory of the School of Mines have repeatedly obtained, by the Kjeldahl process, results on fertilisers which agree closely with those obtained by the more elaborate combustion processes.

We append references to the literature on the process, arranged alphabetically as to authors' names:—

Arnold.—Arch. Pharm. (3rd ser.), xxiii., 177; xxiv., 785. Chem. Centralblatt, 3rd ser., xvii., 337. Zeite. f. Anal. Chem., xxv., 454. Rep. anal. Chem., iv., 97.
Armsby.—Amer. Chem. J., viii., 323.
Von Asboth.—Chem. Centralblatt, 3rd ser., xvii., 161.
Balcke.—Wochenschrift f. Brauerei, i., No. 11.
Bohland.—Arch. f. gessammt. Physiol., xxxv., 454; xxxvi., 102; and xxxvii., 423.
Bosshard.—Zeitschr. f. Physiol. Chem., ix., 63. Zeits. f. Anal. Chem., xxiv., 199.
Brunemann.—Chem. Ztg., viii., 1820.
Czeczetka.—Monatshefte f. Chem., vi., 63.
Dafert.—Sitzungsber. Niedershein. Gesell., 1884, 203. Landwirths. Versuchs Stat., xxxiv., 311.
Farrington.—U.S. Dept. Agric. Bulletin, No. 16.
Hannin.—Zeits. f. Anal. Chem., xxv., 155.
Heffter.—Chem. Ztg., viii., 432.
Hollrung.—Chem. Ztg., viii., 432.
Jodblauer.—Chem. Centralblatt (3rd ser.), xvii., 433.
Kjeldahl.—Zeits. f. Anal. Chem., xxii., 366.
Kreusler.—Zeits. f. Anal. Chem., xxiv., 393. Landwirths. Versuchs. Stat., xxxi., 209.
Kulisch.—Zeits. f. Anal. Chem., xxv., 149.
Lehmann.—Zeits. f. Anal. Chem., xxiv., 388. Zeits. Physiol. Chem., viii., 200.
Lenz.—Zeits. f. Anal. Chem., xxvi., 590.
Märcker.—Zeit. f. Spiritus Ind., viii., 223. Wochenschr. f. Brau., 1886, 190.
Morgen.—Chem. Ztg., viii., 432.
Neal.—Report of N.J. Agric. Exper. Station, 1886.
Petri.—Zeits. f. Physiol. Chem., viii., 200.
Pfeiffer.— Zeits. f. Anal. Chem., xxiv., 388.
Pflüger.—Arch. f. gesammt. Physiol., xxxvi., 102.
Reitmair.—Repert. Anal. Chnm., v., 232 and 262; vii., 4.
Rindall. –Zeits. f. Anal. Chem., xxv., 155.
Reinke.— Wochenschr. f. Brau., 1885, 191.
Rube.—Zeits. f. Anal. Chem., xxiii., 43.
Ross.—Chem. News, lv., 151.
Schmitz.—Zeits. f. Anal. Chem., xxv., 314.
Scovell.—U.S. Dept. Agric. Bulletin, No. 16,
Seyfert.—Chem. Ztg., viii., 1820.
Short.—Amer. Chem. J., viii., 323.
Spencer.—Chem. News, lv., 20.
Stebbins.—Jour. Am. Chem. Soc., vii., 108.
Stutzer.—Repert. Anal. Chem., v., 232, and vii., 4.
Ulsch.—Chem. Centr. (3), xviii., 284. Zeits. gesammt. Brau., 1886, 81; 1887, 3.
Warington.—Chem. News, lii., 162.
Wilfarth.—Chem. Centralbl. (3rd ser.), xvi., 17 and 113.
Wilkinson.—Chem. News, lv., 151.
Yardley.—Chem. News, lii., 220.

Abstracts of many of these papers may be found in—
Journal of Lond. Chem. Soc., xlvi., 364; xlviii., 430, 688, 837, 930, 1261; l., 179, 282, 648, 652, 834, 1071; lii, 78, 298, 863.
Chem. News, xlviii., 101; l., 58; li., 285; lii., 107; lv., 249; lvii., 64.
Zeits. f. Anal. Chem., xxiii., 596; xxiv., 299, 453, 635; xxv., 252, 280, 426, 575; xxvi., 92, 249, 646; xxvii., 73.

PROCEEDINGS OF SOCIETIES.

THE ROYAL SOCIETY.

The following is a list of the principal exhibits at the Ladies' Conversazione on June 6th, 1888:—

Experiments with Soap-bubbles.—Exhibited by Mr. C. V. Boys, A.R.S.M.

These experiments are arranged to show chiefly the power of an air film to prevent two bubbles from coming into real contact. Thus, among other experiments, the outer of two bubbles may be pulled out until it squeezes the inner one into a long oval, but no real contact takes place. If either of these bubbles is coloured with uranine it will, when properly illuminated, appear a brilliant green, while the other one remains clear, showing that they do not really touch, or if the outer one is broken the inner one floats away. An inner bubble filled with gas will carry up an outer one to which are attached a wire ring and other things without really touching it at all.

The rapid diffusion of ether vapour through a soap film is shown in several ways. Thus a bubble which has been floating on ether vapour for a few seconds becomes so heavy that, when lifted into the air, it hangs like a heavy drop; further the vapour, as it oozes through the film, is seen on the screen to fall away in a heavy stream, while the gas which issues from the supporting pipe burns with a large and steady flame, showing still more conclusively that the inflammable vapour has penetrated through the film.

Two bubbles resting against one another instantly coalesce when the most feebly electrified body is brought near, but one bubble resting inside another is completely protected from comparatively powerful electrical influences by the outer one, and so the bubbles remain separate.

Gradational Colour Blender. — Exhibited by Sir Frederick Bramwell, D.C.L., F.R.S.

A cylinder, clothed with different colours varying from end to end of the cylinder, so that, on being revolved, the effect of the blending of the colours in varying proportions is exhibited, and thus the value of these proportions can be compared.

Large Electrical Influence Machine.—Exhibited by Mr. James Wimshurst.

It has 12 disks, each 2 feet 6 inches in diameter, and carrying 16 metal sectors. Will obtain full excitement with less than one revolution of the handle in any condition of the atmosphere. The length of spark is 13½ inches.

New form of Hydrometer for testing the strength of Acids in Electric Batteries and other Apparatus.—Exhibited by Mr. James J. Hicks.

Sir William Thomson's Models of Foam or Froth consisting of Equal Bubbles.—Exhibited by Prof. G. H. DARWIN, F.R.S.

Each bubble is a curvilinear 14-faced space. If a single bubble be dissected from the mass, it is found to be derived from the regular octahedron (two square pyramids base to base) by truncating the six solid angles. Thus the eight faces of the octahedron give rise to eight curvilinear hexagons, and the six solid angles to six curvilinear squares.

In the foam three films meet at 120° at each edge, and of the three which meet two are hexagons and one is a square.—*See Phil. Mag.*, vol. xxiv. (1887), p. 503.

Selecting Microtome at work, illustrating a new Method, by which Series of Sections of Microscopic Objects may be made from fresh or fixed Tissues.—Invented and exhibited by Mr. W. H. CALDWELL, M.A., Fellow of Gonville and Caius College, Cambridge.

(1.) The Selecting Microtome.

The sections are delivered automatically on to glass slides, and either a complete and continuous series, or any required fraction of such (*e.g.*, every $\frac{1}{10}$ section), is received mounted with each section touching its predecessor on the slide.

Series can be made from either frozen or dry objects.

The sections flatten by "surface tension" as they are cut, and being always supported can be cut considerably thinner than by the older methods.

With the best steel razor $\frac{1}{20000}$ inch = $0{\cdot}5\mu$ can be reached.

(2.) *Apparatus for Accurately Imbedding Objects in Celloidin or in Insoluble Gelatin.*—Invented and exhibited by Mr. W. H. CALDWELL, M.A., Fellow of Gonville and Caius College, Cambridge.

(*a.*) Celloidin—

If an alcohol-ether solution of celloidin be poured on the surface of chloroform a jelly of celloidin equal in volume to the original solution rapidly forms.

This is due to the great density of the chloroform preventing any mechanical disruption of insoluble celloidin, while the ether and alcohol readily dissolve in the chloroform.

The apparatus is designed to control this action of chloroform.

(*b.*) Gelatin.

New uses of the Magnifying Spring.—Exhibited by Profs. W. E. AYRTON, F.R.S., and JOHN PERRY, F.R.S.

The end of an ordinary spiral spring made of round wire, such as is used in a spring balance, does not appreciably rotate when the spring is stretched. But by making the metal flat, and winding it up like a thin shaving, a spring is produced, the end of which turns through a large angle for a small axial extension of the spring, the ratio of rotation to axial extension being the greater the smaller the diameter of the spring.

Specimens of the magnifying springs of various sensibilities are exhibited, and they are also shown, applied to—

(1.) Simple apparatus for measuring the coefficient of expansion by heat.
(2.) Vacuum and pressure gauge.
(3.) Micrometer indicating the one twenty-thousandth of an inch.
(4.) Thermometer.
(5.) Portable voltmeter for measuring alternating potential differences, and a large working model showing the principle.

Modified Maxwell Galvanometer with Invariable Sensibility.—Exhibited by Profs. W. E. AYRTON, F.R.S., and JOHN PERRY, F.R.S.

The ordinary torsional suspension is dispensed with, and the controlling couple is produced by the action of the magnetic field on a number of small magnets rigidly attached to the moving coil. Hence, not merely does the deflecting couple for a given current vary with the strength of the magnetic field, but so also does the controlling couple, consequently the deflection for a given current is practically unaffected for wide variations in the strength of the field.

The object of attaching many small magnets to the moving coil is to cause the controlling couple to vary directly with the deflecting couple, even when the strengths of different portions of the field occupied by the coil are varied in very different proportions, a result which is found to occur when one of the stationary magnets alters its magnetism much more than the rest of the magnets forming the compound permanent magnet, or when the field is much distorted by the presence of some large neighbouring magnet.

(1.) *Experiments Illustrating Low-temperature Spectra, in Connection with the Spectra of Meteorites.*—Exhibited by Mr. J. NORMAN LOCKYER, F.R.S.

Spectra of carbon, magnesium, manganese, lead, iron, and barium, at the temperature of the oxy-coal-gas blowpipe.

The celestial bodies, the spectra of which give indications of the lines, bands, and flutings, seen under these conditions, are in all probability at a low temperature.

According to the meteoritic hypothesis, every body in the universe, at the beginning of its history as a self-luminous one, was composed of a sparse swarm of meteorites, and was then in the condition of what we call a nebula. The spectrum of a nebula consists mainly of lines of hydrogen, and the low temperature lines and fluting of magnesium, the latter of which is well seen at the temperature of the Bunsen burner or oxy-coal-gas flame, but is invisible at a higher temperature.

By the subsequent condensation, due to gravity, the temperature of the swarm composing the nebula would be increased, and the result would be one of the so-called "stars" with a bright line spectrum, in which there are flutings of carbon and the lines of iron, sodium, and manganese seen in the oxy-coal-gas flame. Nebulæ and "stars" with bright line spectra are classed together as bodies of group 1.

Further condensation would result in the appearance of absorption bands, owing to the diminution of the interspaces, and we would then have a body of the 2nd group. The dark bands seen in the spectra of these bodies are due to magnesium, manganese, lead, barium, and iron, and there are also the bright flutings of carbon.

(2.) *New Chart of the Pleiades.* Prepared by the Brothers Henry, from photographs taken at Paris, on November 16th, and December 14th, 1887.—Exhibited by Mr. J. NORMAN LOCKYER, F.R.S.

The time of exposure was four hours in each case. These photographs show a much greater area of nebulosity than those taken in 1885, in consequence of the more perfect methods employed.

It will be observed that there are several apparent lines of nebulosity, one of which passes through no less than seven stars. This strengthens the view that stars are sometimes formed by the intersection of two meteor swarms.

In connection with the chart, a map of the spectra of the principal stars in the Pleiades, prepared from the photograph taken by Prof. Pickering for the Henry Draper Memorial, is also exhibited. All the spectra are of the 4th group, and they are arranged on the map in order of temperatures.

Exhibited by WILLIAM CROOKES, F.R.S.:—

Specimens of Auriferous Quartz, Auriferous Blende, and other gold-bearing minerals from Mr. Pritchard-Morgan's mine, Gwynfynnydd, near Dolgelly, North Wales. Ingot of gold from the above mine:—Weight 2128 ounces, or 1 cwt. 33lbs. Value £8400.

Exhibited by Prof. W. C. ROBERTS-AUSTEN, F.R.S.:—

Specimens illustrating an attempt to revive a branch of Art Metal-work now neglected in Japan. The best native examples were made in Nagoya by retainers of the Daimio of Owari.

Thin sheets of metals and alloys are soldered layer upon layer, care being taken that metals which will present diversity of colour come together; holes of varied shapes and depths are then drilled in the mass, or its surface is covered with devices in trench-like cuts of V section, and the metal is hammered until the holes or trenches disappear, being replaced by banded circles or lines. The colours of the layers may then be developed by suitable "pickling solutions."

Descriptive labels accompany the specimens, which include two native examples of "Mokumè" or wood-grain alloy, prepared by the method described above.

Exhibited by Prof. J. W. Judd, F.R.S., *on behalf of the Normal School of Science, and Royal School of Mines, South Kensington :—*

Specimens of Quartz-Crystals, illustrating their internal structure.

(1). Crystal of smoky quartz, with naturally etched faces, showing that it is formed by the complicated intergrowth of two individuals with opposite polarity. (Both of these individuals exhibit left-handed circular polarisation).

(2). Sections cut at right angles to the principal axis of the crystal, and artificially etched with hydrofluoric acid. The sections illustrate the complicated intergrowth of the two individuals and the presence of lamellæ with different etching figures in certain parts of the crystals.

(N.B.—The lamellæ are shown, by their behaviour under convergent polarised light, to consist of alterations of right and left-handed quartz. Their relation to cracks in the crystal shows them to be of *secondary* origin).

(3). Prism-plane of same quartz-crystal, showing that these lamellæ are developed parallel to the rhombohedral planes of the crystal.

(4). Other quartz-crystals exhibiting a lamellar structure, which has been developed by etching with hydrofluoric acid.

NOTICES OF BOOKS.

A Manual of Practical Assaying. By John Mitchell F.C.S. Edited by William Crookes, F.R.S., Pres.C.S. Sixth Edition, Illustrated with 201 Woodcuts. London: Longmans, Green, and Co.

When a scientific or technical work is fully known among specialists, and when the recurring demand for new editions proves that it is appreciated, there can be no need either for an exposition of its scope and character, or for any attack upon or defence of its leading features.

The duties of the editor have been by no means unimportant. Whilst the main characters of the work have been preserved, it has been found necessary to omit much matter which has been superseded, to re-write other portions, and to make additions extending to no fewer than 90 pages.

Among the most important additions which have been found necessary we may mention the account of Mr. D. W. Brunton's automatic sampling machine, a device which saves no inconsiderable expenditure of time and trouble.

The gas- and petroleum-spirit furnaces invented or improved by Mr. Fletcher, Messrs. Griffin, and others are duly described and figured. There is further an account of new reagents and new processes, gravimetric, volumetric, and colorimetric, especially for the assay of iron ores, iron, steel, spiegeleisen, &c. The spectroscope has not, so far, proved itself an available instrument in assaying. Its application to the assay of gold and silver alloys has been attempted by two most skilful chemists, Professor Chandler Roberts-Austen, F.R.S., Chemist to the Mint, and Mr. A. E. Outerbridge, Assistant in the Assay Department of the United States Mint, but the results obtained have been far from satisfactory. It has not been found possible to obtain alloys of gold so absolutely homogeneous that the minute quantity of metal actually volatilised, and yielding the spectrum may be a true representation of the whole ingot. We find no electrolytic methods save those for the assays of copper and of mercury.

Not the least important addition to the work is the full description of the American dry copper assay. The editor disapproves of the Cornish assay, but fears that it will not be superseded for some time, owing to the manner in which it is mixed up with trade usages.

The deteriorating action of bismuth, even in small quantities, upon the ductility of silver is pointed out, and appropriate methods are given for its recognition. The section on gold has also also been improved and extended, especially as regards its detection in poor ores.

The present edition is in every respect an improvement on its predecessors, and should prove highly welcome to assayers, metallurgists, and mining engineers.

Skeleton Notes upon Inorganic Chemistry. Part. I.—Non-Metallic Elements. By P. de P. Ricketts, Ph.D., Professor of Assaying in the School of Mines, Columbia College, N.Y. City, and S. H. Russell, E.M. New York: John Wiley and Sons. 1887.

So far as the writer knows this is a decidedly original work, being intended to aid the student of elementary chemistry in taking notes in the class-room.

The book includes Tables of Atomic Weights and Specific Gravity, the Non-Metallic Elements, arranged alphabetically and indexed, with blank pages of fine writing-paper between. The principal facts and constants of each element are briefly printed on the upper pages (the book opens lengthwise and from the reader), leaving the nearer pages for additional notes and such explanations as the lecturer may utter. A number of blank pages at the beginning and end of the book provide for general notes and memoranda.

These "Skeleton Notes" are not intended to take the place of a text-book; on the contrary, the authors encourage the use of one, and say that much matter has been purposely omitted for the student to supply by filling out the blank pages. The authors believe that the student, by having before him, in a condensed form, the leading points in regard to each chemical element and its compounds, will learn to work in a systematic way in following lectures, and in the study of text-books.

The arrangement of the compounds is such as to present very clearly the manner in which they are formed. In the comparison of members of the same group—as bromine, chlorine, iodine, and fluorine—the "skeletons" show at a glance the relations which exist between these elements and their compounds.

As a handbook for the lecture-room, study, or laboratory, the information wanted will be found in a concise form, and more quickly than by reference to the ordinary text-books.

The authorities consulted, and from which the Notes have been compiled, are Watts's "Manual of Chemistry" and Roscoe's "Elementary Chemistry," and great pains have been taken to insure accuracy and to state only what is known and most important.

The heads under each element are commonly:—Name, history, occurrence, preparation, properties, detection, applications, compounds; distinctive type makes it easy to comprehend the arrangement of material.

The book promises to be a useful addition to the tools of students of elementary chemistry. The name of Prof. Ricketts, well known by his "Notes on Assaying and Assay Schemes," is a guarantee of accurate work. A good feature is that the book does not contain too much; thus we note the entire absence of equations, the student being left to his own resources in this and other particulars.

We notice that under Boron and Tellurium the sections on name and history are omitted,—probably an oversight. The derivation of Selenium is also wanting. We object to the terms iodides of potash and of soda. These slight blemishes, easily corrected in the plates, do not detract from the value of this useful manual and note-book combined.

CORRESPONDENCE.

CONSTITUTION OF ANTIMONIUM-POTASSIUM OXALATE.

To the Editor of the Chemical News.

SIR,—I should be glad if you would allow me to point out an error in Mr. Percy Kay's paper "On the Analysis and Composition of Antimonium Potassium Oxalate." which appeared in the CHEMICAL NEWS, vol. lvii., p. 193. The constitutional formula ascribed to the double oxalate, $K_4Sb_2(C_2O_4)_6$, is incorrect, since the carboxyl groups of the oxalic acid are represented as C—O—OH, and not

$$\begin{array}{l} \quad\quad\quad\quad | \\ C \begin{array}{l} =O \\ -OH \end{array}, \end{array}$$

as they should be.

Since I shall no doubt be held responsible for the contents of this paper, emanating as it does from this College, I may be allowed to state that it was published during my absence and without my consent. I have waited until now to see whether anyone else might draw your attention to the error, but as this has not been the case, I take this opportunity of doing so myself.—I am, &c.,

EDMUND KNECHT.

Bradford Technical College,
June 2, 1888.

THE ACIDITY OF CARBONIC ACID.

To the Editor of the Chemical News.

SIR,—Your correspondent, Mr. Farrington, will no doubt pardon me if I point out that his observation as to the decolouration of an alkaline solution of phenol-phthalein by carbonic acid (CHEM. NEWS, vol. lvii., p. 214) has been already published. The whole subject has been almost exhaustively treated in a paper by myself and my son, C. Napier Draper, which appeared in the CHEMICAL NEWS of April 1st, 1887 (vol. lv., p. 143).

Mr. Farrington has, however, done useful service in calling attention to what is really an excellent lecture experiment. Perhaps the best way of performing this is to discharge part of the contents of a syphon of soda-water into the coloured liquid.—I am, &c.,

HARRY NAPIER DRAPER.

Dublin, June 6, 1888.

APPARATUS FOR GENERATING GASES.

To the Editor of the Chemical News.

SIR,—I notice in your issue of the 1st inst. (CHEMICAL NEWS, vol. lvii., p. 213) an apparatus for the preparation of H, CO_2, and H_2S, by Mr. Johnson, of King's College, and should like to state that I have devised a similar apparatus, which has been in use at Finsbury Technical College during the past nine months.

I have made several improvements on my original form, and those of your readers interested will find full particulars of the same in Messrs. Townson and Mercer's new Catalogue.—I am, &c.,

HENRY CONRAD CORAM.

City and Guilds of London Institute.
Technical College, Finsbury, London, E.C.,
June 12, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of emperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 22, May 28, 1888.

Researches on Ruthenium; the Ruthenates and Hepta-ruthenates.—H. Debray and A. Joly.—Ruthenium is attacked by a melting mixture of nitre and potassa, and it forms with the alkali a compound soluble in water, in which it gives a very intense orange-red solution. This is a characteristic reaction of ruthenium. Although there is an evident analogy of composition and of reactions between potassium rutheniate and hepta-rutheniate and the corresponding manganate and permanganate, yet there is no relation of isomerism between the salts of the acids of ruthenium and those of manganese. Potassium rutheniate is hydrated, whilst the manganate is anhydrous like the sulphate.

Researches on the Application of Rotatory Power to the Study of the Compounds formed by the Action of Neutral Sodium and Potassium Tungstates upon Solutions of Tartaric Acid.—D. Gernez.—Tartaric acid forms, with neutral potassium tungstate, a compound, $C_8H_6O_{12}+2(KOWO_3)$, and which corresponds to the maximum rotation observed, which is 23 times greater than that produced by the tartaric acid present.

The Production, in the Dry Way, of Crystalline Ferric Hydrates.—G. Rousseau and J. Bernheim.—The authors have sought to crystallise sodium ferrite by heating ferric oxide with caustic soda. As this method did not succeed, they employed ferric hydroxide and obtained compounds in which basic water is substituted for the larger part of the soda in the ferrite. On using a mixture of sodium chloride and sodium carbonate in place of caustic soda they obtained a new hydrate analogous to the former. The crystalline tables derived from the calcination of a mixture of iron sulphate and sodium chloride do not correspond to oligistic iron, but are a ferric hydrate containing a little soda. The weight of the soda and the water of these hydrates, though variable in absolute amount according to the temperature of the experiment and the nature of the fluxes, are in the approximately constant proportion of 1 : 3. All attempts to substitute potassa for soda have failed.

On Rhodium Sesquisulphide.—E. Leide.—The author describes the preparation of this compound in the dry and the wet way, and the formation of double sulphides of rhodium and of the alkaline metals.

On Two Isomeric Naphtho-quinoleines.—Alphonse Combes.—The α compound melts at 44° and distils without decomposition about 360° to 362°. The β-compound melts at 66° to 67° and distils at 380°, but takes a strong red colour unless distilled at a vacuum.

On Oil of Cajeput.—R. Voiry.—On fractional distillation this oil yields a terpilenol, which has no action upon polarised light. There were further obtained acetic, butyric, and valerianic ethers mixed with a carbide boiling at 160° in a vacuum.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. Series 5, Vol. iii., No. 26.

Report by M. Bérard, on behalf of the Committee of Chemical Arts, on the Cryptographic Processes of M. Schlumberger.—The author merely states that M. Schlumberger introduces into the paper pulp substances which become coloured under the influence of certain reagents. The process has been successfully adopted by two railway companies.

Zeitschrift fur Analytische Chemie.
Vol. xxvi., Part 6.

Gravimetrical Determination of Total Solids and Fat in Milk and Butter by Means of Woody Fibre.—F. Gantter.— The author, instead of the paper proposed by Dr. M. A. Adams, uses for absorbing the milk "wood-stuff," as obtained by the sulphite process for the paper-manufacture. It requires merely to be dried and extracted with petroleum ether in order to remove all traces of resinous matter. Two grms. of wood-stuff are placed in the capsule intended for the evaporation of the milk, along with a small glass rod, dried at 105° until the weight becomes constant, and weighed along with the capsule. During weighing the capsule should be closed with a well-fitting cover. Of the sample of milk, which has been previously placed in a small phial, weighed, and stoppered, 5 to 6 grms. are poured as evenly as possible upon the wood-stuff in the capsule, and the exact quantity taken is ascertained by re-weighing the phial. The capsule is then placed upon the water-bath, and care is taken, by stirring and pressure, that the wood-stuff sucks up all the milk, leaving the sides of the capsule scarcely moist. During the evaporation the whole is stirred occasionally, so that no particles of the wood are left adhering to the metal. If at the beginning of the process small quantities of milk not absorbed are seen on the sides and the bottom, they are pressed and rubbed with the wood by means of the glass rod until the spot appears perfectly clean and bright. In an hour the contents of the capsule are dried up so far that the operation may be completed in the drying closet, which takes an hour and a half longer. The total solid matter is shown by the increased weight of the capsule. The dry matter thus obtained is enclosed in paper in the ordinary manner and placed in Soxhlet's apparatus.

Determination of Tannin.—F. Gantter.—The author has examined the proposed method of precipitating tannin, not with hide-powder, but with ferric acetate. In 10 c.c. of the solution of tannin the total proportion of tannin + non-tannin is determined. Then, on the one hand, 50 c.c. of the tannin solution were precipitated with hide and 10 c.c. were again titrated after the completion of the precipitation. On the other hand 50 c.c. of the same solution were precipitated with 10 c.c. ferric acetate (decinormal) made up to 100 c.c. and then 20 c.c. = 10 c.c. of the original solution was titrated. The results showed that with many tanning materials higher values were obtained by the hide process than the ferric acetate process.

Volume and Proportion of Carbon in the Gases Evolved on Dissolving Iron in Acids. — Helge Bäckström and Gunnar Paijkull.—This paper requires the accompanying illustrations.

Remarks on Dr. Anton Baumann's Paper on the Determination of Ammonia in Arable Soils (*Zeitschrift Anal. Chemie*, vol. xxvi., p. 302).—W. Knop.—The author cannot admit that Dr. Baumann has contributed to the solution of the question of the determination of ammonia in soils.

MEETINGS FOR THE WEEK.

Wednesday, 20th.—Geological, 8.
—— Meteorological, 7.
Thursday, 21st.—Royal, 4.30.
—— Chemical, 8. Ballot for the Election of Fellows. "Chlorofumaric and Chloromaleic Acid, their Derivatives and Magnetic Rotatives," by Dr. W. H. Perkin, F.R.S. "Combustion by Means of Chromic Anhydride," by C. F. Cross and E. J. Bevan. "Metoxylensulphonic Acids," by Dr. G. T. Moody. "Researches on Isomeric Changes," by Dr. H. E. Armstrong. "A New Method for the Production of Mixed Tertiary Phosphines." by Dr. N. Collie.
Friday, 22nd.—Quekett Club, 8.
Saturday, 23rd.—Physical, 3. "Note on Continuous Current Transformers," by Prof. S. P. Thompson, D.Sc.

NOTES AND QUERIES.

History of Chemistry as Known to the Ancients.—(Reply to Gertrude Amburger).—Consult Berthelot's most interesting work—"Les Origines de l'Alchimie." Also "Eleven Centuriea of Chemistry," by Professor Ferguson, of Glasgow; Address to the Chemical Section of the Philosophical Society of Glasgow, November 11th, 1878.—W. N. Hartley.

History of Chemistry as Known to the Ancients.—(Reply to Gertrude Amburger).—The following works may assist your correspondent:—"Allgemeine Encyclopädie der Wissenschaften und Künste u. alphabetische Folge." von genanten Schriftstellern bearbeitet und herausgegeben von T. S. Ersch und T. G. Gruber, Professoren zu halle; 1 Section, 16 Theil; Leipzig, 1827; see "Chemie," pp. 247—263. Also Meyer's "Conversations Lexicon," Band vii., Abth. 2; Hildburghausen, 1845; see "Chemiatrie und Chemie," &c., pp. 79, 137. Also "Bibliotheca Chemica" (E. A. Luckold); Göttingen, 1859. "Bibliotheca Chemica et Pharmaceutica" (R. Ruprecht); Göttingen, 1872. "Quellen-Literatur der theoretisch-organischen Chemie" (E. T. Wolff); Halle, 1845. "The Catalogue of Scientific Serials, 1633—1876," by Samuel H. Scudder (Cambridge, Library of Harvard University, 1879), has all the chemical publications of Europe and America.—Patrick O'Brien, Kingsland.

Alcohol in Water.—(Reply to "Delph.")—Your correspondent will find what he requires, namely, a reference to M. Müntz's estimation of alcohol in natural waters, in the Cantor Lectures, "Fermentation and Distillation," delivered before the Society of Arts, May 12th to 26th, 1884. Alcohol was detected in the Vartry water supplied to Dublin.—W. N. Hartley.

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London: J. and A. CHURCHILL, 11, New Burlington Street.

CIVIL SERVICE COMMISSION.—Forthcoming Examination. Assistant to the Lecturers on Chemistry, &c., at the Royal Artillery College (25—30), 3rd July.
The date specified is the latest at which applications can be received. They must be made on Forms to be obtained with particulars from the Secretary, Civil Service Commission, London, S.W.

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THE CHEMICAL NEWS.

Vol. LVII. No. 1491.

NOTE ON THE VOLUMETRIC DETERMINATION OF URIC ACID.*

By A. M. GOSSAGE, B.A., Oxon.

Dr. Haycraft has recently proposed a method for the volumetric determination of uric acid in urine (*Brit. Med. Journ.*, 1885, 2, p. 1100) which has great advantages over all former methods in that it is much quicker and easier to manage. The uric acid from 25 c.c. of urine is precipitated by silver nitrate after previous addition of sodium carbonate (to prevent reduction) and ammonia (to dissolve silver chloride, &c.); this precipitate is then collected, washed, and dissolved in nitric acid, and the amount of silver present in this solution ascertained by Volhard's method, *i.e.*, titration with ammonium sulphocyanate; from this the amount of uric acid can be calculated. "In order to test the accuracy of the process," he says, "I prepared several solutions of acid urate of sodium of known strength. To these I added various quantities of common salt, magnesium sulphate, and phosphate of soda, in order to imitate as far as possible the urinary secretion. On estimating the uric acid in these solutions, I obtained wonderfully correct results. In all cases not much more than a milligramme was lost during the process, and may be simply accounted for by the fact that no salt of uric acid is absolutely insoluble. . . . . In order further to test its accuracy, 50 c.c. of urine were divided into two equal portions; to the first 25 c.c. of a solution of acid urate of sodium of known strength were added; to the second 25 c.c. of water were added. When estimated the two fluids show a difference equal to the quantity of salt added." Results very closely corresponding to this were obtained.

These results do not agree with results obtained by Salkowski (Pflüger's "Archiv," vol. v., 1872, p. 210) and Maly (Pflüger's "Archiv," vol. vi., p. 201). Salkowski proposed a volumetric method for the determination of uric acid, very similar to that proposed by Dr. Haycraft; in this he added excess of silver nitrate and estimated the excess of silver present. He gave up this method, however, as on examining the silver precipitate obtained from urine, after complete precipitation of the phosphates by magnesia mixture, he found that it contained magnesium as well as silver, and that the proportion of magnesium to silver varied considerably in precipitates from different urines, though constant for the same urine. Haycraft considers that the presence and variation in amount of magnesium in these precipitates may be due to varying quantities of magnesium ammonium phosphate in them. This is, however, impossible, as the phosphates were precipitated by Salkowski previously, and the urine allowed to stand for twenty-four hours before filtration to ensure their complete separation. Salkowski's results were confirmed by Maly, who found that, if in the presence of salts of calcium, magnesium, potassium, and ammonium, a solution of a urate be precipitated by silver nitrate, the precipitate contains these metals as urates as well as silver urate.

As a test of the accuracy of Haycraft's method, I examined samples of various urines, both by his method and by Salkowski's method, which is universally acknowledged to be the most reliable, and the accuracy of which has been proved by experimental evidence. This method consists in taking 250 c.c. of urine, adding 50 c.c. of magnesia mixture to precipitate phosphates, and then adding to 240 c.c. of the filtrate (which are equivalent to 200 c.c. of the urine) silver nitrate to precipitate the uric acid. This precipitate of silver urate is decomposed by sulphuretted hydrogen after being suspended in water. The liquid is then acidified, filtered hot, and evaporated to small bulk, and the uric acid allowed to crystallise out. These crystals are then dried and weighed. The results obtained are given below.

The results obtained by Haycraft's method were always considerably higher than those obtained by Salkowski's. The reason of this is that Dr. Haycraft has assumed that the silver precipitate from urine consists of an urate containing only 1 atom of silver in the molecule, whereas the proportion of silver in this precipitate is always larger, and varies in amount in different urines. If we assume that the precipitate contains 2 atoms of silver in a molecule of urate and divide the results obtained by Haycraft's method by two, we see that in two cases they are about equal to, in the rest less than those obtained by Salkowski's method. The proportion of the results obtained by one method to those obtained by the other varies. This agrees with the results of Salkowski's researches, from which one would expect that the results obtained by Haycraft's method would not bear a constant relation to the results obtained by Salkowski's, and that the halves of the results by the former method would be lower than, in most cases, those obtained by the latter.

* A Paper read before the Royal Society, June 7th, 1888.

1 c.c. NH_4CNS = 0·00168 Uric Acid.

	Salkowski (200 c.c. urine).		Haycraft (25 c.c. urine).		
Expt.	Quantity of uric acid obtained.	Mean percentage.	No. of c.c. of NH_4CNS required.	Mean equivalent quantity of uric acid.	Percentage.
I.	0·168 gr.	0·084	(*a.*) 16·2 c.c. (*b.*) 16·3 ,,	0·027	0·108
II.	0·07 gr.	0·035	(*a.*) 11·8 c.c. (*b.*) 11·4 ,, (*c.*) 11·0 ,,	0·019	0·076
III.	(*a.*) 0·098 gr. (*b.*) 0·1045 ,,	0·051	(*a.*) 12·3 c.c. (*b.*) 12·1 ,,	0·0205	0·082
IV.	(*a.*) 0·068 gr. (*b.*) 0·073 ,,	0·035	(*a.*) 10·7 c.c. (*b.*) 11·1 ,,	0·018	0·072
V.	(*a.*) 0·154 gr. (*b.*) 0·160 ,, (*c.*) 0·165 ,,	0·08	(*a.*) 16·3 c.c. (*b.*) 16·4 ,,	0·027	0·108

ON BUMPING EBULLITION (SOUBRESAUTS).

By CHARLES TOMLINSON, F.R.S., F.C.S.

The *Journal of the Chemical Society*, June, 1888, contains among its abstracts a method contrived by A. Reissmann for preventing the bumping of vessels during distillation by means of bits of pumice, sunk, where necessary, by means of platinum wire.

We are very much in want of an *Index Rerum* to prevent the frequent repetition of old discoveries by young investigators. The Royal Society's Catalogue gives the names, but no plan has as yet been decided on for an index of subjects.

In January, 1869, I read a paper before the Royal Society "On the Action of Solid Nuclei in Liberating Vapour from Boiling Liquids." In this paper the cause of bumping is investigated, and the action of a large number of nuclei is tested. The nuclei employed were common charcoal, charcoal from box-wood and from cocoa-nut shell, coke, platinum-sponge, meerschaum, pumice, and similar porous bodies. The liquids operated on were water, spirits of wine, turpentine, and other essential oils. One of the most remarkable results was the action of nuclei in increasing the distillate, in some cases as much as 25 per cent. For this purpose a glass flask with a wide neck was filled about one-third with distilled water for example; it was boiled over a gas-burner, rapidly weighed, and replaced over the burner. After boiling twenty minutes it was weighed again. The flask was once more filled to the original quantity, and the nucleus added; it was boiled and weighed as before, the gas flame remaining unaltered all the time. Other arrangements were made in the case of inflammable liquids. One result may be given:—

Distillate from water only, 262 grains; from water with nucleus (in this case cocoanut-shell charcoal), 334 grains.

Ratio of results as 100 : 127·4.

The subject was practically illustrated before the Society of Arts on April 7th, 1869, in a paper "On the Theory of Boiling in Connection with Some Processes in the Useful Arts," and in the following month before the Pharmaceutical Society in a lecture, a report of which is contained in the Chemical News, vol. xix., p. 267.

Highgate, N., June 13, 1888.

REMARKS ON SOME STATEMENTS BY MR. ROWLAND WILLIAMS ON THE DETERMINATION OF THE AMOUNT OF MORPHIA PRESENT IN OPIUM.

By E. F. TESCHEMACHER and J. DENHAM SMITH.

We have thought it possible that our paper under the above title might have provoked some observations from chemists interested in the subject, and had intended then to reply to such *en bloc*, and also to notice Mr. Williams's statements, where requisite, occurring in Chemical News, vol. lvii., pp. 134—135. As our paper has not elicited any such remarks we will address our attention to the statements of Mr. Williams.

This gentleman pays us the compliment of adopting our title, but without acknowledging its source. He then proceeds to tell his readers a "Story without an End" of two Persian gentlemen who came to him about two years since "with the object of ascertaining the most reliable methods of estimating morphia in opium." He speaks of having examined with his Persian pupils a large number of the most promising processes he could find on the subject, but confines himself to a few details of their experiences and results from the three methods of the British, German, and American "Pharmacopœias," and after "making two or three dozen determinations of morphia by the B.P. process finally abandoned it altogether." In so doing we hold him to be fully justified, even without the dozens of determinations he speaks of. He regards himself and pupils as having been "in the same predicament" as ourselves in taking a wrong quantity of solution of opium. Now we take leave to disclaim having been in any predicament. We had to follow the published process of the "Brit. Pharm.," whether right or wrong, to attain our object. Not so Mr. Williams, to whom the correction of an obvious blunder was open, if he so pleased, instead of observing that there was "no clear reason" for it, in which he is most correct, seeing that no reason exists, whether clear or obscure, for this error being made and left unaltered; nevertheless the evident blunder was always followed in his determinations. The German and American methods are equally condemned, and as the Persian pupils have vanished from the scene it is obvious that these gentlemen must either be examining opiums by faulty methods, or have given it up as a bad job.

Our author proceeds to detail a process which is nearly identical with that of Mr. Stillwell, even to the rubber-tipped glass rod, but uses far more alcohol, and omits the "wash well with ether" of Mr. Stillwell, which makes it certain that his results are less accurate than those of Mr. Stillwell. Mr. Williams now refers to the titration of morphia, a subject which may be more conveniently considered later on. Then his readers are informed that "during the last few months he has slightly altered his methods of estimating the amount of morphia in opium. This alteration proves to be the use of 200 grains of opium, 100 fluid grains of alcohol, 600 of ether, and 45 of solution of ammonia, double his former quantities, "the remainder of the process to be conducted as usual," a curt and meaningless direction. Mr. Stillwell, we observe, has most wisely devoted several pages of his pamphlet to minute directions to be followed by the analyst.

In these processes Mr. Williams has been guilty of plagiarism from Mr. Stillwell, whilst omitting the careful and continuous use of ether on which Mr. Stillwell lays great stress. Mr. Williams, in describing these methods, "began a series of experiments," speaks of "my general plan of procedure" and "my present methods," but never mentions Mr. Stillwell in connection with them, whilst telling the readers that he "latterly placed implicit reliance on the methods which I have just described," and again, that "my results were obtained by the process upon which I have latterly staked my faith." This *staking of his faith* seems to us to be an excellent illustration of Pope's axiom—

"Your true no meaning puzzles more than wit."

We may now return to the question of titration. Mr. Williams observes:—"Unless I mistake their meaning, Messrs. Teschemacher and Smith appear to be under the impression that they are the only chemists who test the purity of the morphia precipitate by titration with standard acid." Mr. Williams has read our paper, and should be surprised to find that he is utterly mistaken both as to our statement, which was that "titration has not been used by any of the chemists whose processes we have investigated," and also as to the meaning he has contrived to attach to it. He then refers us to a letter of his in the Chemical News, vol. lv., p. 69, wherein he says:—"I check my results by titrating the precipitate with decinormal sulphuric acid. The titration with acid generally gives figures from 0·10 to 0·25 per cent lower than those obtained by simply weighing the morphia." Surely this titration might be as well omitted. Any process which will yield within 0·10 to 0·25 per cent of morphia might be gladly accepted as most satisfactory. For ourselves, we cannot accept this statement as meaning what it says, whatever it has been meant to convey. It is wholly opposed to our own experience, as we state in our directions where treating of the use of benzene, that morphia is thus obtained "free from other opium alkaloids and narcotin, but still containing colouring and possibly

other organic matters to the extent of 3 to 10 per cent." Mr. Williams seems to have acquired the art of using language significant to himself if puzzling to his readers. We have already adduced instances of this, but no more striking examples can well be met with than in this letter of his in 1887, wherein he seeks to vindicate his claim to the advocacy of titration in determining the amount of morphia present in opium, which was made known to us and other analysts by Mr. Allen in 1882, so that we fear that his claim must be rejected. Again he "highly recommends Mr. Stillwell's method, as it may be relied upon to extract *all* the morphia present, which most other processes fail to do." The italics are Mr. Williams's, as if he desired to emphasize a statement which, oddly enough, is the very reverse of his presentment. We greatly doubt whether any method fails "to extract *all* the morphia present." The true *crux* and difficulty is to *isolate* the morphia and determine its amount when extracted.

To our judgment Mr. Stillwell has succeeded more nearly than any chemist we have so far met with in determining the amount of morphia present in opium, and this is, in the main, owing to his taking pains and to a lavish use of ether in the hope of getting rid of the narcotin. He would have taken a further step forward had he anticipated the utility of employing sections 6 and 7 of our method, and even using ether to the finely-ground supposed morphia instead of benzene, a reagent which has been steadily ignored by chemists, although advised by us more than a decade since.

In conclusion we must ask our readers to remember that we have never placed implicit reliance on our method, nor asserted our belief in its giving accurate results, nor staked our faith upon it, but were content to say "All we pretend to do is to return results certifying to the amount of pure crystallised morphia which can be obtained from a given sample of opium. And further, that we can and do obtain more morphia than has been procured from opium by other analysts."

ON A CYANIDE OF ARSENIC.

By G. W. BLYTHE.

In reading the various works on chemistry I have noticed that, although many arsenic compounds are there mentioned, yet the cyanide, AsCN, is left out; and I therefore judged from this that it had not yet been discovered. I further considered that, as prussic acid is obtained by the reaction of hydrochloric acid on various cyanides, cyanide of arsenic might be formed by the reaction of arsenious chloride on some cyanide, such as that of mercury, silver, or sodium. I therefore introduced arsenious chloride and mercury cyanide into a retort, connected with a cooled receiver, and distilled. Presently a colourless volatile liquid, exactly resembling in appearance and odour prussic acid, passed over, but, coming into contact with some moisture (the retort and receiver had been rinsed, but not dried) a white powder made its appearance, upon seeing which I immediately conjectured that cyanide of arsenic *had* been obtained and had been decomposed by the moisture (just as the corresponding chloride is under similar circumstances) into arsenious and prussic acids.

A ferrocyanide of arsenic, but in combination, has been discovered for some time, and will be found mentioned in "Ure's Dictionary."

Previous to *really* discovering cyanide of arsenic I had thought that it might be produced by distilling white arsenic with strong prussic acid or a saturated solution of cyanide potassium; but only prussic acid seems to pass over. The odour of the prussic acid passing over in this instance certainly differed from that of prussic acid obtained by the usual methods, not being so sweet or fragrant.

Perhaps cyanide of arsenic might also be obtained by distilling in the dry way one part of metal arsenic with six parts of mercury cyanide, just as the corresponding chloride is prepared by distilling one part arsenic with six parts mercuric chloride; but I have not tried this way.

VOLUMETRIC DETERMINATION OF BROMINE.

By JOHN TSAWOO WHITE.

Little did I dream that the factor 1·6 found for bromine rested on a miscalculation. I find that the factor for the thiosulphate solution is 1·5 times its assumed value. The values of the bromine found thus becoming, without the use of an extra factor, still less, further experiments became necessary.

A zinc bromide solution was prepared by digesting silver bromide with zinc and water. The bromine was determined, after liberating it with potassium permanganate and sulphuric acid, by decinormal thiosulphate. Then the bromine liberated by permanganate and aluminium sulphate was determined with the following results: any errors due to the thiosulphate solution will be eliminated.

Taken.	Found.
0·0086	0·0078
0·0430	0·0411
0·0430	0·0430

The permanganate used in former experiments was far too large. 10 c.c. of a solution, 1 in 25, will be sufficient for 0·1 grm. Br. The aluminium sulphate is added when everything is ready for the distillation to guard against loss of bromine. Neither potassium bromide nor zinc bromide gives off bromine when boiled with potassium permanganate alone. Mixtures with chlorides and iodides were not tried, as former experiments showed that chlorine and iodine are not evolved. This reaction of bromine with potassium permanganate and aluminium sulphate may be used for its detection, and for preparing it pure, perhaps on a manufacturing scale, instead of the present fractionation process.

Rangoon College, May 22, 1888.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending May 31st, 1888.

By WILLIAM CROOKES, F.R.S.;
WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To General A. De Courcy Scott, R.A.,
Water Examiner, Metropolis Water Act, 1871.

London, June 7th, 1888.

Sir,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from May 1st to May 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The waters during May have fully maintained their excellent and unimpeachable character for purity.

The slight turbidity recorded in some half dozen samples supplied by the East London Water Company, is explained by certain local disturbances, consequent upon fixing many hundred hydrants, in accordance with directions received by the Company from the Metropolitan Board of Works. The operation of fixing a hydrant necessarily involves the scouring and disturbance of a long length of main. The organic matter in the East London Company's water, however, during May, shows a reduction over that of last month, the oxygen required per gallon (on the average) to oxidise the organic matter being 0·036 grain during May, against 0·044 grain during April.

We are, Sir,
Your obedient Servants,
William Crookes.
William Odling.
C. Meymott Tidy.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, June 7th, 1888.

Mr. William Crookes, F.R.S., President, in the Chair.

Professor Ferguson and Messrs. John Campbell Fell and Thomas E. Lindsey were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Walter Bromley Cooley, 5, Dudley Street, Wolverhampton; Archibald Carlyle Mounsey Ingram, 5, Buchanan Terrace, Paisley; Walter M. Gardner, Brookfield Terrace, Headingly, Leeds; Frank Pullinger, B.A., Alexander Park, Oldham; Clement T. Rhodes, 18, Bute Street, South Kensington.

The following were elected Fellows of the Society:—Messrs. Joseph Campbell, John Dunn, William Burns-Featherstone, Albert L. Guiterman, James C. Hamilton, James Mair, B.Sc., John James Morgan, Edward W. A. Augustine Mayhew, Frederick Ernest Pollard, Albert John Sach, Mark S. Wade, M.D.

The following papers were read:—

45. "*The Chemical Action of some Micro-organisms.*" By R. Warington.

The organisms whose action has been studied were *B. subtilis*; two bacilli isolated from soil; one from a visible growth in a solution which had nitrified; a micrococcus isolated from another culture in which it was present as an impurity; 18 organisms, many pathogenic received from Dr. Klein, F.R.S., and one from Dr. W. R. Smith.

1. *The Hydrolysis of Urea.*—The ability of each organism to render a sterilised 25 per cent solution of urine alkaline was tested. In every case but two there was either no increase of alkalinity in one week at 22°, or the increase was so slight that it could not be safely concluded that ammonia was produced. In the case of the *M. ureæ* isolated by Dr. Smith, a rather considerable increase of alkalinity took place. A somewhat smaller but very distinct increase occurred with *B. fluorescens non liquescens*. A much larger increase of alkalinity than in either of these instances was obtained when the urine was seeded with a fragment of arable soil.

2. *Behaviour in Milk.*—The curdling of milk by micro-organisms is effected either by the production of lactic acid, or apparently by the formation of a rennet-like ferment. The amount of lactic acid required to curdle milk depends on the temperature, the amount being smaller the higher the temperature.

Among the organisms examined five have distinctly acidified milk, but in very different degrees. *Staphylococcus candidus* produces too little acid to cause curdling, even when the milk, after acidification, is placed in boiling water. The bacillus of infantile diarrhœa and *B. termo* produce a greater acidity, curdling milk speedily at 32°, but fail entirely to curdle it at 22°. *M. gelatinosus* curdles milk speedily at 22°, and even at 10° after many days. The two organisms, *B. fluorescens liquescens* and Koch's chlorera spirillum, curdle milk readily at 22°, without producing any appreciable acidity; the latter organism will indeed curdle milk made alkaline with sodium carbonate without destroying the alkalinity. We have here, apparently, a typical case of curdling by means of a ferment. Two of the acidifying organisms which curdle milk, *M. gelatinosus* and *M. ureæ*, act apparently in part by means of a ferment, as the acidity produced by them when the milk is curdled is quite insufficient in itself to effect curdling at the temperature of the experiment. Soil from an arable field readily curdles milk, even at 10°, but without producing at the time an appreciable acidity; it acts plainly by a ferment. During the action of soil on milk much gas is evolved, even at 10°. No gas was observed during the action of any of the organisms examined, save in an experiment with the bacillus of infantile diarrhœa at 37°.

Five organisms, *B. subtilis*, *B. anthracis*, *B. floccus*, *B. toruliformis*, and Finkler's comma are active peptonisers. The milk, after a few days at 22°, becomes clear immediately beneath the surface, and this clear space slowly extends till the whole of the milk has lost its opacity. On moving the tube after the action has begun, it is found that the opaque portion is more or less gelatinised. The clearing of the milk is due to the gradual dissolution of the jelly. The clear fluid is rich in peptone. It has been supposed that the liquefaction of gelatin by bacteria is due to the production of a ferment. The whole of the liquefying bacteria experimented on show evidence of the formation of ferments when grown in milk. The organisms which simply acidify do not liquefy. Soil peptonises after curdling, the curd first formed slowly redissolving. A small class of organisms, *B. fluorescens non liquescens* and the bacillus of septicæmia (mouse and guinea-pig), render milk after a time decidedly alkaline, and the milk from this cause loses much of its opacity, but no other change is produced. Several organisms grow freely in milk without altering its appearance or its reaction to litmus-paper. Cultivation in milk is an excellent method of distinguishing micro-organisms, the possible results being very varied, especially when the effect of temperature is observed.

3. *Reduction of Nitrates.*—Nearly the whole of the organisms examined have been cultivated both in broth containing nitre and in a 20 per cent solution of urine containing nitre, and generally at two temperatures, 20—23° and 32—37°. The experiments were made in half-filled bottles with cotton-wool stoppers. The amount of nitrate reduced in urine was always small, and varied probably on account of the variable composition of the medium. The reduction of nitrate in broth was frequently both rapid and very considerable. In cases in which the organisms would bear a high temperature the reduction was always more energetic at the higher than at the lower temperature. The organisms which appeared to possess the greatest power of reducing nitrates to nitrites were—

B floccus, *B. fluorescens non liquescens*, B. of swine fever, *M. ureæ*, *M. gelatinosus*, *Staph. candidus*, *Staph. luteus*. Next to these stand the following, which also reduce nitrates freely:—*B. termo*, B. of typhoid fever, B. of infantile diarrhœa, B. of cholera, B. of septicæmia, *B. anthracis*, B. Denicke's comma, *Staph. albus liquescens*.

Far below these comes *B. subtilis*, which produces no

nitrite in the urine solution, but always yields, after some time, a trace of nitrite in broth at the lower temperature, and a much more marked amount at the higher temperature. *Streppococcus scarlatinæ* yields a mere trace of nitrite in broth cultures.

The following organisms failed entirely to effect reduction to nitrites:—*B. fluorescens liquescens*, *B. toruliformis*, *B. sulphureus*, B. Finkler's comma, *B. comma noma*, *M. aureus*.

Most of the non-reducing organisms were also cultivated in broth containing nitre covered by a layer of paraffin oil, by which means the access of oxygen was to a considerable extent excluded. In no case was any reduction of nitrates observed.

No evolution of gas was noticed in any of the above cultivations. In experiments made in solutions seeded with arable soil, air being excluded, the reduction of nitrates was complete, gas being evolved, neither nitrate nor nitrite remaining.

4. *Oxidation of Ammonia to Nitrate.*—Solutions of various compositions were employed, in all of which the addition of a little soil produced active nitrification. Nearly all the organisms already enumerated were sown in one or other of the solutions, and some in several different solutions. In no case was nitrification certainly observed. Minute traces of nitrate were in some instances found, but these always failed to increase. The author now proposes to commence a systematic study of the organisms contained in soil.

Discussion.

Dr. Percy Frankland said that he also had so far searched in vain for the nitrifying organism; but he could not agree that no one had been successful. Heræus had succeeded in isolating two or three organisms which were stated not only to induce the formation of nitrite in urine solutions, but also in mineral solutions containing ammonium salts. He had, however, himself shown that Heræus was undoubtedly wrong in attributing nitrifying powers to a number of organisms, his mistake arising from his ignorance of the fact that nitric acid is normally present in urine. The effects of organisms in milk had been very fully described by Hueppe, who had shown that coagulation might take place independently of the presence of acid. He was not satisfied with the method adopted by Mr. Warington for sterilising milk—perhaps the most difficult of all fluids to sterilise; sterilisation might, however, be effected by heating on five successive days at a temperature of 65—70°, and it had long been known that milk so treated differed from steam-sterilised milk. Had Mr. Warington repeated the experiments sufficiently often to be sure of the results being constant? micro-organisms were often extremely capricious in their chemical action. Thus, under certain conditions, *M. prodigiosus* entirely changed its character—becoming colourless, but the colourless form would regain the pigment-producing power on changing the cultivating medium.

Mr. Warington, in reply, said that he was under the impression that Heræus had found nitrification to take place only in those cases in which soil was introduced into the experimental fluids. The results he had obtained when using milk were perfectly constant, and he had met with no failures in sterilising; this probably was attributable to the fact that he had used fresh country milk, milked directly into sterilised bottles. He had observed the change in colour of *M. prodigiosus*, but Dr. Klein, to whom he submitted his cultures, had found that the forms were distinct, and that only white organisms could be obtained from the pure white form.

46. "*The Optical and Chemical Properties of Caoutchouc.*" By J. H. Gladstone, Ph.D., F.R.S, and Walter Hibbert, F.I.C.

This is an extension of the observations on caoutchouc published in Dr. Gladstone's paper on Essential Oils (*Chem. Soc. Trans.*, 1886, 609). The substance experimented on was obtained from the best commercial Para rubber. Many attempts were made to separate the two supposed modifications, and to remove an oxidised product. The most promising method seemed to be to dissolve the rubber in cold chloroform and precipitate partially with a little alcohol, but no good separation was effected, and the results of analysis gave usually about 3 per cent of oxygen. One small specimen, very carefully prepared and dried, contained carbon and hydrogen in almost exactly the proportions $C_{10} : H_{16}$, with only 0·5 per cent deficiency.

Optical analyses are given of 17 preparations dissolved in benzene. They were prepared from different specimens in different ways, and variously dried, and two of them were second precipitates from chloroform or ether solutions. The refraction and dispersion equivalents vary considerably, but they all agree in showing that the $C_{10}H_{16}$ must have more than one pair of carbon-atoms doubly linked. All the dispersion equivalents and 11 of the refraction equivalents also exceed what theory requires for two pairs of carbon-atoms so combined, namely, refraction equivalent, 75·2, and dispersion equivalent, 4·8. They fall short of what would be required by three pairs, at any rate in the case of refraction (theory, refraction equivalent, 77·4, and dispersion equivalent, 5·6), but the presence of a little oxygen in the substance examined would reduce the refraction and dispersion considerably. The observations on the best specimen already described give the highest figres, the mean of which are, refraction equivalent, 77·23, and dispersion equivalent, 5·50. There is little doubt, therefore, that the main constituent of caoutchouc is a compound which has three pairs of carbon-atoms doubly linked. If this be the case, the molecular formula cannot be C_5H_8, like isoprene, or $C_{15}H_{24}$, like cidrene, as these would give respectively one and a half and four and a half pairs of carbon-atoms, united by double linking. It cannot contain the hexagonal ring, but must be expressed graphically by a chain formula. This may account for the wide difference of properties between caoutchouc and the various essential oils.

The action of the halogens on caoutchouc dissolved in chloroform was examined. Chlorine gave rise to a substance which could be obtained in yellow scales, the best preparation giving figures which seem to point to $C_{10}H_{14}Cl_8$. Bromine in weak solution acts upon caoutchouc in chloroform, and by volumetric methods it was determined that 136 grms. of the caoutchouc used combine with 303 grms. of bromine on an average, which indicates $C_{10}H_{16}Br_4$ as the first product of the action. The prolonged action of bromine causes the separation of hydrogen bromide, and the formation of a compound precipitable by ether as a white solid, $C_{10}H_{15}Br_5$. It seems not improbable that this is formed from a compound, $C_{10}H_{16}Br_6$, by the elimination of HBr. Iodine has no action.

The action of heat was also studied. The caoutchouc hydrocarbon dissolved in toluene remains unchanged optically on exposure to a temperature of 200°.

As is known, the various oils given by dry distillation contain carbon and hydrogen in the same proportions as the original caoutchouc, but the structural re-arrangement is most materially modified, as indicated by the following optical constitutional formulæ:—

Caoutchouc.. $nC_6''C_4H_{16}$, Caoutchene.. $C_4''C_6H_{16}$,
Isoprene. .. $C_4''CH_8$, Heveene. .. $nC_2''C_3H_8$.

47. "*An Apparatus for Maintaining a Constant Pressure when Distilling under Reduced Pressure.*" By W. H. Perkin, F.R.S.

The essential parts of the apparatus are a barometer tube in connection with the exhausted apparatus, and a valve through which air is admitted when, by the action of the pump, the pressure becomes reduced below the prescribed point. A copper rod armed with a platinum point passes through the upper end of the barometer tube.

and can be adjusted at any desired height; so soon as the mercury rises and touches the point of the rod an electric circuit is completed and the valve is raised and air admitted. The valve is a glass sphere in a glass seating, the sphere being suspended from the armature of an electromagnet; the sphere has a weight attached to it, which causes it at once to fall back when the circuit is broken. Even under a pressure of 60 m.m.—the lowest obtained with the water-pump used—the apparatus renders it possible to maintain the pressure constant to within a millimetre.

PHYSICAL SOCIETY.

June 9th, 1888.

Professor Reinold, F.R.S., President, in the Chair.

Mr. J. L. Howard, D.Sc., was elected a Member of the Society.

The following papers were read:—

"*On the Analogy between Dilute Solutions and Gases as regards Gay-Lussac's and Boyle's and Avogadro's Laws.* By Prof. van't Hoff. Presented by Prof. Ramsay, F.R.S.

If a dilute aqueous solution of sugar (say 1 per cent) be placed in a vessel, A (the walls of which are permeable to water but not to sugar molecules), and immersed in a large quantity of water, B, water will pass from B to A until a certain difference of pressure exists between the inside and outside of A, that difference depending on the temperature and concentration of the solution. The pressure is called *osmotic pressure*, and the walls of A are said to be *semi-permeable*. Such a vessel may be artificially produced by depositing ferrocyanide of copper on unglazed porcelain, but many of the experiments dealt with in the paper have been made with the cells of plants, the walls of which form good *semi-permeable membranes*. At constant temperature the osmotic pressure is found to be proportional to the concentration of the solution, and for a given concentration the pressure is proportional to the absolute temperature. Similar results have been obtained with solutions of KNO_3, K_2SO_4, NaCl, &c., and Soret has found that if a solution be heated unequally at different parts the warmer parts are less concentrated, just as in gases under similar conditions the warmer parts are more rarefied. The numerical results are in fair accordance with those deduced from the laws above stated. Theoretical proofs of the laws are given in which reversible cycles and the second law of thermodynamics are made use of. By similar reasoning the author concludes that "under equal osmotic pressure, and at the same temperature, equal volumes of all solutions contain the same numbers of molecules, and, moreover, the same number of molecules which would be contained in a gas under the same conditions of temperature and pressure. These results are confirmed by Pfeffer's direct determinations of osmotic pressure and Raoult's experiments on the "molecular lowering of vapour pressure," and the "molecular depression of the freezing-point of the solvent." The latter part of the paper contains applications to chemical phenomena.

Prof. Rücker regretted that the names Boyle's Law and Gay-Lussac's Law had been so persistently made use of in the paper, as he thought a wrong impression would be spread as to the nature of the phenomena. He also considered it probable that the proportionality observed was merely the result of the smallness of the ranges over which the experiments had been made.

Mr. H. Crompton took exception to the imaginative character of the reasoning, and thought much more experimental proof was required before the results could be accepted for any but very small ranges of concentration.

In answer to Prof. Reinold, Prof. Ramsay said the experimental data were not obtained by van't Hoff himself, but were taken chiefly from Raoult's determinations.

"*On a Method of Comparing Very Unequal Capacities.*" By Mr. A. H. Fison, D.Sc.

One coating of each condenser is joined to earth, and to one end, A, of a high resistance (20,000 or 30,000 ohms) through which a current is flowing. The small condenser is charged to the P.D. existing between the ends, A, B, of the resistance, and discharged into the large one. This is repeated a great number of times. If C be a point between A and B, the resistance between A and C may be varied until the P.D. between them is equal to that between the coatings of the condensers after n operations. If the insulated coatings be now joined to C through a galvanometer no deflection will result. The relation between the capacities C_1 and C_2 of the large and small condensers is given by—

$$\left(1 + \frac{C_2}{C_1}\right)^n = \frac{R_{AB}}{R_{BC}},$$

where R_{AB}, R_{BC} are the resistances between A B and B C respectively.

Since time is required to perform the operations the instantaneous capacities cannot be compared, and accordingly the measurements are taken after a definite time of electrification.

A special rotating key was shown for performing ten operations per revolution, in which a trigger arrangement was provided for stopping the rotation after a predetermined integral number of revolutions.

The method has been used for comparing a small air-condenser with a microfarad. The capacity of the former was also calculated electrostatically (correction being made for the edges), and that of the latter measured electromagnetically by a ballistic galvanometer. The results give a value for v equal to $2{\cdot}965 \times 10^{10}$. In these experiments the capacity of the rotating key was allowed for. Under favourable conditions capacities in the ratio of 1 to 1000 or 1 to 10,000 can be compared with an accuracy of ¼ per cent.

Prof. Ayrton thought the novelty of the arrangement was in the rotating key, as the method of comparing unequal capacities by charging the smaller and discharging it into the larger a considerable number of times had been described and used by himself and Prof. Perry in their experiments on "The Specific Inductive Capacity of Gases."

Mr. W. Lant Carpenter exhibited a "*New Form of Lantern*," recently constructed by Mr. Hughes, of Dalston.

The mahogany body is hexagonal, and each of the three front sides is provided with condensers and projecting arrangements. The back side opens to give access to the radiant, which in this case is a Brockie-Pell Arc Lamp, but if necessary a lime light can be readily substituted. The lamp is fixed to the base board, and the body can be rotated through 60° on either side of the central position, thus allowing any of the three nozzles to be directed towards the screen. The three sets of condensers are placed so that their axes intersect at a point about which the radiant is placed. The centre nozzle is fitted as a lantern microscope, with alum cell and various sets of condensing lens and objectives, and a space in front of the main condensers is provided for polarising apparatus. The focussing arrangement consists of a skew rack and pinion and a fine screw adjustment; and the whole microscope can be easily removed and a table polariscope substituted. The right-hand nozzle is arranged for the projection of ordinary lantern slides, and the left-hand one is provided with an adjustable slit for spectrum work. A small table sliding on rails serves to carry the prisms, and the same rails support projecting lenses.

Prof. S. P. Thompson congratulated Mr. Lant Carpenter on his selection of the Brockie-Pell lamp as the radiant, for, in addition to its being a focussing lamp, it is unique

in the fact that it works satisfactorily on either constant current or constant potential circuits.

"*Note on some Additions to the Kew Magnetometer.*" By Prof. T. E. Thorpe, F.R.S., and Prof. Rücker, F.R.S.

In their Magnetic Survey of Great Britain and Ireland the authors have experienced considerable difficulty in making the necessary adjustments of the small transit mirror used for determining the geographical N. point from observations on the sun. To make the required adjustment it is necessary to obtain an image of the cross wires reflected from the mirror, and, owing to the large amount of extraneous light and the insufficient illumination of the cross wire, the image is difficult to see. To exclude extraneous light a tube is placed between the transit mirror and the telescope, and a small screen placed behind the mirror. The cross wires are illuminated by light reflected from a small platinum mirror introduced between the eye-piece and the cross wires, which are viewed through a hole in its centre. The mirror is placed at 45° to the axis, and reflects a considerable quantity of light on the cross wires when directed towards a bright part of the sky. In some cases it is advisable to take observations of the sun without first adjusting the transit mirror, and afterwards correct the error introduced thereby. To do this a finely divided scale is placed in the plane of the cross wires, and from the position of the image, as indicated by the scale, the correction can be made. Observations taken with the mirror in adjustment, and others taken when out of adjustment and subsequently corrected, give very concordant results.

The Rev. Father Perry said the improvements described were of great importance, for difficulties similar to those experienced by the authors had caused him to abandon the Kew magnetometer for field work, and to use a theodolite instead.

NOTICES OF BOOKS.

A Short Text-Book of Inorganic Chemistry. By Dr. Hermann Kolbe, late Professor of Chemistry in the University of Leipzig. Translated and Edited by T. S. Humpidge, Ph.D., B.Sc., late Professor of Chemistry in the University College of Wales, Aberystwith. Second Edition, Revised. London: Longmans, Green, and Co.

The original work of Professor Kolbe is of such excellence that an English version of it might be considered welcome, overstocked as we are with chemical manuals. In noticing the first edition we could not fail to be struck with the editor's statement that in "adapting the book for English students certain alterations and additions were necessary," and that they had been made accordingly with Dr. Kolbe's full consent. In other words, the original work was written for students whose primary object is "to know," and it had to be modified for others whose main purpose is, compulsorily, "to pass." We regret that such should be the case, but we cannot blame the late Prof. Humpidge.

The second edition, now before us, has been completed by Prof. D. E. Jones, in consequence of the lamented death of the original editor. The alterations made are such as recent improvements demand, such as the adoption of the new atomic weight, 9·1, for glucinium, and cannot be said to affect the general character of the work. That in face of the absolute plethora of elementary chemical treatises a second edition should be called for within four years is a proof that its value has been recognised by teachers and students.

Certain Novel Hydrates of the Gases.—M. Villard.—The author has succeeded in combining methane, ethane, ethylene, acetylene, and nitrogen monoxide with water.—*Comptes Rendus*, Vol. cvi., No. 23.

CORRESPONDENCE.

SOLUTION.

To the Editor of the Chemical News.

Sir,—Will you allow me a few words in reply to Professor Pickering's letter in Chemical News, vol. lvii., p. 220. It would take up too much of your valuable space to enter into the subject fully, as the proofs of my theory of solution are cumulative, and do not depend on any one set of phenomena, and I based it originally on very different data from thermo-chemical results, and only brought forward these as striking corroborations of its truth.

Prof. Pickering quite ignores the *inverse* relations I pointed out in my last communication, which indeed are the essential points. I do not know if he accepts as generally true the results of the researches of Thomsen and others, that the heats of combination, solution, &c., are really represented by the number of heat units given. If he does not, then I have nothing more to say: his difference is with those authors, as I carefully stated in my various papers on the subject that my arguments were based on the assumption that these were actual facts. If he does, then the relations pointed out are simply statements of facts, however obtained, which he admits. He says these relations are due to N being constant in these salts. Now this appears to me much the same thing as saying that in various accounts of different amounts the relations of the various operations in these accounts are due to the balance being always the same. This is to invert the order of things altogether; the balance is the same because of certain relations existing between the operations. N really represents no definite operation whatever, and is simply the balance remaining after many chemical changes, and is constant in these cases because the heats of solution, &c., vary in the manner I have pointed out. Prof. Pickering acknowledges his errors so frankly, although he endeavours to get out of them by the rather clumsy method of showing that they neutralise one another, that I have a better opinion of him than he seems to have of himself, judging by the last paragraph of his letter.—I am, &c.,

William Durham.

ALUMINIUM IN IRON.

To the Editor of the Chemical News.

Sir,—I should be glad if some of your readers would give me some information on the following facts. There are some aluminium alloys with iron in the market for use in steel making of which it is said "that it is practically impossible at present" to ascertain by analysis the presence of aluminium "at all by any known method," for the apparent reason "that other constituents are mistaken for it."

Have your readers any experience of this difficulty and why it cannot be identified by the usual method of separation from iron by means of pure sodium hydrate. The alloys in question are perfectly soluble in aqua regia, and ought certainly to be amenable to the usual methods.—I am, &c.,

Engineer.

APPARATUS FOR GENERATING GASES.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. lvii., p. 241, there is a communication from Mr. Coram, of Finsbury Technical College, to the effect that an apparatus for generating gases, described by Mr. Johnson, of King's College, is not new, and adding that he has had a similar apparatus in use nine months.

May I be allowed to point out to the two gentlemen

concerned that precisely such an apparatus was in use in Professor Bunsen's laboratory at Heidelberg so long ago as 1879, at which period I had the honour of studying there. The apparatus I speak of was principally used for the evolution of CO_2, and was essentially as described by Mr. Johnson, with one notable exception—the exit tube was provided with a stopcock, thus enabling the evolution of gas to be stopped immediately. The stopcock being closed the pressure of the CO_2 forced the HCl out of the generating tube, thus leaving the whole apparatus non-acting; all that need be done for a fresh experiment was to open the stopcock, when in flowed the acid, and evolution re-commenced.—I am, &c.,

George H. Bostock.

Messrs. J. Muspratt and Son's Laboratory,
Widnes, June 19th, 1888.

[We have received other communications saying that similar apparatus to the one recently described in our pages by Mr. Johnson has been for some years in use in various chemical laboratories. This is a proof that the device is useful, and the thanks of chemists are therefore due to the one who first publishes this information to the world.—*Ed.* C.N.]

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of emperature are Centigrade unless otherwise expressed,

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 23, June 4, 1888.

Action of Alkaline Phosphates upon the Alkaline-Earthy Oxides.—L. Ouvrard.—Baryta is characterised by its resistance to the formation of double salts and to displacement by alkalies. Lime, on the contrary, merely yields double salts, whilst strontia takes an intermediate position.

A Contribution to the Study of the Ptomaines.—Oechsner de Coninck.—The author has prepared two chloro-mercurates and an iodomethylate of the ptomaine $C_8H_{11}N$. The iodomethylate of this ptomaine behaves in the same manner as the iodomethylates of the pyridic bases in presence of an alkaline lye. Certain pyridic bases, extracted from Dippel's oil, present under similar conditions reductive powers as remarkable as that of the novel ptomaine.

Researches on the Fixation of Nitrogen by the Soil and by Plants.—Arm. Gautier and R. Drouin.—The authors have analysed the part played by the different elements of a fertile soil, mineral or organic, living or lifeless, in the fixation of atmospheric nitrogen, whatever may be the form in which such nitrogen exists in the air. As to the reality of the phenomenon of the assimilation of free nitrogen, that is a point upon which they have expressly reserved their conclusions.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. Series 5, Vol. iii., No. 27.

This issue contains no original chemical matter.

Zeitschrift fur Analytische Chemie.
Vol. xxvi., Part 6.

Criticism of the Direct Methods for Determining Tartaric Acid in Lees and Argols.—Dr. Anton Bornträger.—The author examines the application of the method of Warington and Grosjean in various cases.

Determination of Tartaric Acid.—F. Gantter.—The author pronounces the method of Goldberg (*Zeitschrift Anal. Chemie*, xxii., p. 270) very satisfactory where it is merely required to determine total tartaric acid, whether existing as potassium bitartrate, calcium tartrate, or in the free state. The conditions for the success of the process, as investigated by Weigert, are that the excess of potassium carbonate must be as small as possible, acetic acid must be added in corresponding excess, the washing must be prolonged, and the mixture of potassium carbonate and neutral tartrate must, on admixture with alcohol, still contain water.

Determination of the Free, Semi-combined, and Combined Carbonic Acid in Neutral Mineral Waters.—W. Borchers.—The author refers to a process for this purpose which he described in the *Journal fur Prakt. Chemie* (xvii., 353) as early as 1878. He mentions then and there that the results are the more accurate the less alkaline bicarbonate is present. He therefore adds to waters containing such alkaline bicarbonates a soluble neutral salt of the alkaline earths, preferably barium chloride, thus producing an alkaline chloride and, *e.g.*, barium bicarbonate. The latter, on heating, is decomposed into free carbonic acid and barium monocarbonate. The quantity of crystalline barium chloride to be used for 300 c.c. of water is 1 to 1·5 grm.

Filtering Flask with a Ground Funnel.—F. Allihn.—This apparatus, which is shown in the figure, is for use in combination with a filter-pump.

A Steam-Calorimeter.—R. Bunsen.—The principle is bringing a substance of a known low temperature into a current of saturated watery vapour of a known temperature and heating it there to the temperature of the steam. A certain quantity of liquid water is then deposited upon the substance and its weight is determined. The quantity of this water depends exclusively upon the quantity of heat used in heating the substance. See also J. Joly in *Proc. Royal Society* for November, 1887.

Pipette for Measuring Bromine.—A. Simon.—This apparatus is distinguished from ordinary pipettes by its capability of being closed at the lower end by a small glass bead weighted with mercury and drawn out at one side to thread of moderate thickness, and projecting out of the pipette about 2 m.m. The bromine is kept under water. The pipette is thrust first into the stratum of water, a little water is allowed to enter by tapping the pipette, which is then thrust down to the bottom. The valve rises and bromine enters, and can be raised by suction to any required height.

The Different Systems of Filter-pumps.—T. Fairley.—From the *Journal of the Society of Chemical Industry.*

An Improved Funnel.—C. Nickels.—From the *Journal of the Society of Chemical Industry.*

Apparatus for the Continuous Development of Gases.—G. Tissandier.—From the *Bulletin de la Société Chimique.*

Maintenance of Constant Temperatures.—W. Ramsay.—From the *Journal of the Chemical Society.*

An Annular Burner for Heating the Upper Part of Crucibles.—W. A. Shenstone.—From the *Journal of the Chemical Society.*

Arrangements for the Evaporation of Fluids by Heat from Above.—J. W. Gunning.—The arrangement consists of an iron plate supporting the crucible and standing on four feet. Through four holes in the plate near its corners there project four large Bunsens, whose flames burn above the bottom plate. Above the whole there is placed a heavy cast-iron plate resting upon four taller feet, and projecting beyond the bottom plate on all sides. The hot air thus produced and the radiating heat from the upper plate quickly evaporate the liquid without danger of spirting.

A Smelting Furnace. — A. Gawalowski. — This apparatus cannot be intelligibly described without the accompanying figure.

Titration of Solutions of Iodine.—W. Kalmann.—The author dilutes with water, introduces sulphuretted hydrogen until the colour is discharged, and then titrates with decinormal soda, using methyl-orange as an indicator.

Determination of Small Quantities of Sodium Chloride along with Potassium Chloride.—F. Röttger and H. Precht.—The authors had previously proposed to grind the sample to a fine powder, put 20 grms. into a beaker along with 40 grms. alcohol at 90 per cent, stir frequently with a glass rod, and, after standing for half an hour, add drop by drop ½ c.c. of a 10 per cent solution of potassium carbonate, stirring meanwhile. The liquid is separated from the undissolved portion by decantation, filtration, and washing, and in the weighed residue from the evaporation of the alcoholic solution the potassium chloride is determined as usual and the sodium chloride is determined as difference. As an abbreviated process the authors place 20 grms. of the mixture in a flask graduated to 110 c.c., fill up to three-fourths with alcohol at 90 per cent, shake frequently, and after half an hour add ½ c.c. of a 10 per cent solution of potassium carbonate, fill up to the mark, and shake well. Of the clear liquid 50 c.c. are then treated as above directed.

Volumetric Determination of Chromium.—W. J. Sell.—From the Chemical News.

Analysis of Nickel.—G. Langbein.—In the electrolytic separation of nickel from an ammoniacal solution containing nickel and manganese the latter metal does not, as it is commonly assumed, deposit completely at the positive electrode, but the nickel deposited at the negative electrode contains metallic manganese, varying in quantity according to the strength of the current. To avoid this error the ammoniacal solution of nickel must be made free from manganese, which is effected by precipitating the iron oxide present by means of ammonia in the absence of ammonium chloride, and thus effecting the simultaneous elimination of manganese.

Separation of Nickel from Chrome Iron, Manganese, and Aluminium in Ores, Slags, &c.—Thomas Moore.—From the Chemical News.

Indirect Determination of Fluorine.— S. Bein.— This paper requires the accompanying figure. A. E. Haswell points out that Bein's method had been previously used by Ketzinsky for detecting fluorine in minerals and and in the ash of plants.

The Indirect Determination of Chlorine, Bromine, and Iodine by the Electrolysis of their Silver Compounds, and Experiments on the Transformation of these Silver Compounds by Means of the Halogen Compounds of the Alkali Metals.—In general either the mixture of the silver chloride and bromide is converted into metallic silver by reduction in a current of hydrogen, or it is converted into silver chloride by heating in a current of chlorine. Both these methods are rendered inaccurate by the possible volatilisation of a little silver. A different method has been proposed by F. Maxwell Lyte in the Chemical News (xlix., 3).

Execution of the Thalleioquin Reaction. — G. Vulpius.—The author proposes instead of chlorine water the use of potassium chlorate and hydrochloric acid. For the reaction to succeed it is necessary that there should be an excess of hydrochloric acid, so that no potassium chlorate may remain undecomposed.

Detection of Bromine in the Alkaloidal Hydrochlorates.—A. Weller.—In many of these compounds bromine cannot be detected by the direct addition of chlorine water and shaking with carbon disulphide, as the bromine at once forms compounds with the alkaloids which discolour the carbon disulphide. In the case of quinine, quinidine, cinchonine, cinchonidine, strychnine, and morphine the alkaloid is precipitated with soda-lye; morphine is thrown down with sodium carbonate and codeine with the same reagent.

The Alkaloids of Aconitum Napellus.—A. Jürgens. —The chemico-forensic detection of aconitine can be effected only by means of physiological experiments. The colour-reactions with phosphoric acid, sulphuric acid, and sugar, with phospho-molybdic acid and ammonia, are not produced with pure aconite.

Wrightine and Conessine.—According to Warnecke Polstorff, and Schirmer, these two bases are homologous, but not identical. Identity is not, however, excluded in view of their percentage composition and their melting-points.

Alkaloids and Jaborandi Leaves.—Eric Harnack.—From *Liebig's Annalen*.

Differences in the Reactions of Strychnine and Gelsemine.—M. Raimondi.—To avoid confounding these two alkaloids the author specifies the following characteristic points :—On contact with potassium dichromate and terhydrated sulphuric acid, gelsemine gives a sky-blue colour traversed by green stripes, finally becoming entirely green. Strychnine, on similar treatment, gives a violet, changing to brick-red, and turning yellow on dilution. Strong sulphuric acid dissolves gelsemine with a yellow-brown colour, turning purple-red on heating; whilst strychnine dissolves colourless in the cold, turning yellowish brown on heating. Strong sulphuric acid and sugar colour gelsemine reddish blue, whilst strychnine is not coloured in the cold.

Detection of Glucose.—C. Agostini adds to 5 drops of the liquid in question 5 drops of a solution of gold chloride (1 : 1000) and 2 drops of a solution of caustic soda (1 : 20), and heats to a boil. On cooling, if glucose is present, there appears a splendid violet colour.

A Modification of the Process of Dumas for the Determination of Nitrogen.—M. Raulin.—From the *Bulletin de la Soc. Chimique*.

MISCELLANEOUS.

New Gas-pipette.—We beg to call the attention of chemists to an improved form of Hempel's gas-pipette, recently devised by Messrs. Harris and Co., of Birmingham. This pipette differs from the ordinary type by having, instead of the long capillary tube, a capillary tube with a stop-cock at its centre, bent at right angles from top of bulb. These pipettes are made with the end of the capillary tube straight, or bent at right angles and drawn out to a point. The pipettes can be used with a Lunge's

nitrometer, or similar apparatus, in which case the three-way tap of the nitrometer is connected to the straight capillary tube of the pipette. Burettes are made by the same firm for use with the above pipettes, having a three-way tap at top and another lower down. Above the upper tap is a conical cup, into which may be placed the conical end of the pipette and the joint made air-tight by means of a short piece of flexible tubing. The three-way tap is for use with pipettes having straight capillary tubes.

Welsh Gold Mining.—In reference to the proposed formation of a Company for working Mr. W. Pritchard-Morgan's gold mine in North Wales, it may interest our readers to know that the gold in the ingot weighing 1 cwt. 33 lbs., exhibited at the recent Soirée of the Royal Society by Mr. Crookes, came from the Chidlaw lode in this mine, and that some of the richest specimens of auriferous quartz, blende, and other gold-bearing minerals exhibited at the same time were actually quarried by him from the same place. Mr. Crookes has been acquainted with these auriferous deposits for twenty-five years, and in October last he spent a fortnight in examining this particular shoot of gold, and in prospecting in the neighbourhood.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

French Technical Terms.—Would any reader kindly inform me the meaning of the following terms:—"*Pureté vivien*" (applied in the analysis of sugar-beets), and "*démariage*" (applied in agriculture)?—CHEMICUS.

CIVIL SERVICE COMMISSION.—Forthcoming Examination. Assistant to the Lecturers on Chemistry, &c., at the Royal Artillery College (25—30), 3rd July.
The date specified is the latest at which applications can be received. They must be made on Forms to be obtained with particulars from the Secretary, Civil Service Commission, London, S.W.

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THE CHEMICAL NEWS.

Vol. LVII. No. 1492.

EXPERIMENTS ON CARBON AT HIGH TEMPERATURES AND UNDER GREAT PRESSURES, AND IN CONTACT WITH OTHER SUBSTANCES.*

By the Hon. CHARLES A. PARSONS.

The primary object of these experiments was to obtain a dense form of carbon which should be more desirable than the ordinary carbon for use in arc lamps, and at the same time to obtain a material well suited for the formation of the burners of incandescent lamps.

There were a considerable number of experiments made in which the conditions were somewhat alike, and many were almost repetitions with slightly varied pressures and temperatures. They may, however, be divided into two distinct classes: the first in which a carbon rod surrounded by a fluid under great pressure is electrically heated by passing a large amount through it; the second in which the liquid is replaced by various substances, such as alumina, silica, lime, &c.

The arrangement of the experiment was as follows:—A massive cylindrical steel mould, of about 3 inches internal diameter and 6 inches high, was placed under a hydraulic press; the bottom of the mould was closed by a spigot and asbestos-rubber packing—similar to the gas-check in guns; the top was closed by a plunger similarly packed,—this packing was perfectly tight at all pressures. In the spigot is a centrally bored hole into which the bottom end of the carbon rod to be treated fits; the top end of the carbon rod is connected electrically to the mould by a copper cap, which also helps to support the carbon rod in a central position. The bottom block and spigot are insulated electrically from the mould by asbestos; and the leading wires from the dynamo being connected to the block and mould respectively, the current passes along the carbon rod in the interior of the mould.

The fluid is run in so as to cover the rod completely. The plunger is then free to exert its pressure on the liquid without injuring the carbon. The pressure in the mould is indicated by the gauge on the press.

Experiments. Class I.

Among the liquids tested were benzene, paraffin, treacle, chloride and bisulphide of carbon.

The pressures in the mould during the several experiments were maintained at from 5 to 15 tons per square inch; the initial size of the rod was in all cases ¼ inch, and the current from 100 to 300 ampères.

Results.—In some of these experiments a considerable quantity of gas was generated, and the press had to be slightly slacked back during the experiment to accommodate it and maintain the pressure constant.

In all cases there was a soft friable black deposit of considerable thickness on the carbon.

In no case was the specific gravity of the carbon rod increased by this process; there was no change in appearance of the fracture, excepting when chloride of carbon had been the fluid,—it was greyer in this case.

The rate of burning of samples placed in arc lamps was not diminished by the process. Various rates of deposition were tried, but with the same result, and the conclusion seems to be that under very high pressures—such as from 5 to 15 tons per square inch—the deposit of carbon by heat from hydrocarbons, chloride of carbon, bisulphide of carbon, treacle, &c., is of a sooty nature, and unlike the hard steel-grey deposit from the same liquids or their vapours at atmospheric or lower pressures.

Experiments. Class II.

In these experiments the asbestos-rubber packing was omitted, the plunger and spigot being an easy fit in the mould. A layer of coke powder under the plunger formed the top electrical connexion with the rod.

No. 1. Silver sand or silica was run around the carbon rod, and pressures of from 5 to 30 tons per square inch applied; the rod was usually about ¼ inch diameter, and currents up to 300 ampères passed.

Results.—The silica was melted to the form of a small hen's egg around the rod. When the current was increased to about 250 ampères the rod became altered to graphite, the greater the heat apparently the softer the graphite. There was no action between the silica and the carbon, the surface of the carbon remained black, and there were no hard particles in or on the carbon rod.

Other substances, such as an hydrated alumina and mixtures of alumina and silica, gave the same results.

The density of the carbon was considerably increased, in some cases from normal at 1·6 to 2·2 and 2·4: in these cases the carbon appeared very dense, much harder than the original carbon, and about as hard as the densest gas-retort carbon. No crystalline structure was visible.

The specimens were treated with solvents, and there appeared no indication of the surrounding substance having penetrated the substance of the rod; the carbon was undoubtedly consolidated by 30 per cent.

In some cases carbon in the form of soft crystals of graphite exuded from specimens that had been kept for some weeks; the material surrounding the rod was alumina saturated with oil.

No. 2. Pure hydrated alumina, carbonate and oxide of magnesia and lime, all rapidly destroyed the carbon rod, by combining with it, the hydrated alumina forming large volumes of gas of which it appeared to be a constituent. With the carbon, on account of the great diminution of bulk, no analysis was made; the gas issued from the mould explosively at from 10 to 12 tons per square inch. The alumina was found in a crystalline crust like sugar around where the rod had been. Hardness that of corundum, and semi-translucent.

No. 3. The following is the most interesting experiment of the series:—

On the bottom of the mould was a layer of slaked lime about ¼ inch thick, over this silver sand 2 inches, then another layer of lime of the same thickness as the former, finally a layer of coke-dust, and then the plunger. With a pressure of from 5 to 30 tons per square inch in the mould, currents from 200 to 300 ampères were passed through the carbon of from ¼ to $\frac{5}{16}$ diameter.

In from ten to thirty minutes the current was generally interrupted by the breaking or fusing of the rod, or by the action of the lime in dissolving it at the top or bottom. On opening the mould when it had cooled a little, the silica usually appeared to have melted to an egg-shaped mass, and mixed somewhat at the ends with the lime; the surface of the carbon appeared acted on, and sometimes pitted and crystalline in places; silica adhered to the surface, and beneath, when viewed under the microscope, appeared a globular cauliflower-like formation, of a yellowish colour, resembling some specimens of "bort." *

After several days' immersion in concentrated hydrofluoric acid, this formation remained partly adherent to the carbon; on the surface of the carbon was a layer or skin about 1·64th of an inch thick, of great hardness, on the outside grey, the fracture greyer than the carbon, but having a shining coke-like appearance under the microscope.

* A Paper] the Royal Society, June 14th, 1888.

* The bort-like powder is not acted on by hydrofluoric and nitric acids mixed.

The powder scraped off the surface of the rod has great hardness, and will cut rock crystal when applied with a piece of metal faster than emery powder. It has, under the microscope, the appearance of bort; the minute particles seem to cling together; they are not transparent as a rule, and though some such particles are found among them, it is not clear that such are hard.

When a piece of the skin has been rubbed against a diamond or other hard body the projecting or hard portions have a glossy coke-like appearance.

A piece of the skin will continue to scratch rock crystal for some time without losing its edge. It will scratch ruby, and when rubbed for some time against it will wear grooves or facets upon it. When a cut diamond is rubbed on the surface of the skin it will cut through it into the carbon beneath, making a black line or opening about $\frac{1}{4}$ inch long, the facet on the diamond—originally $\frac{1}{32}$ inch diameter—will have its corners evenly rounded, and its polished surface reduced to about one-half its original area; the appearance of the edges is as if they had been rubbed down by a nearly equally hard substance.

The subject of the last experiment is scarcely sufficiently investigated to warrant any definite conclusions.

The substance, in the several ways it has so far been tested, seems to possess a hardness of nearly if not quite the first quality; but on account of the minuteness of the particles which appear more or less cemented together, and are more cohesive before the action of acid, it is very difficult to determine this.

The mode of formation is not inconsistent with the conditions of pressure, temperature, moisture, lime, silica, and other substances which appear to have existed in the craters or spouts of the Cape Diamond Mines.

From the few experiments that have been made it appears that at pressures below 3 tons per square inch the deposit does not possess the same hardness, though somewhat similar in appearance.

What part the lime and silica play, whether the former only supplies moisture and oxygen which combine with the carbon, or whether the presence of lime is necessary to the action, is not clear.

We may, however, observe that so far it seems as if the lime and moisture combining with the carbon form a gas or liquid at great pressure, which combines with the silica, forming some compound of lime, silica, and carbon, or perhaps pure carbon only, of great hardness.

THE MINIMUM POINT OF CHANGE OF POTENTIAL OF A VOLTAIC COUPLE.*

By Dr. G. GORE, F.R.S.

In a previous communication on "The Effect of Chlorine on the Electromotive Force of a Voltaic Couple" (*Roy. Soc. Proc.*, May 3rd, 1888) I described a phenomenon which I now venture to term the "Minimum Point of Change of Potential of a Voltaic Couple." In that description a "thermo-electric pile" is mentioned as having been used for the purpose of balancing the electromotive force of the couple, whilst finding the minimum point of change." As very few persons possess a thermo-electric pile suitable for the purpose, I have devised and employed the following arrangement, by means of which the use of the pile may be dispensed with:—

Take a voltaic couple, composed of an unamalgamated strip, or stout wire of zinc or magnesium (the latter is usually the best), and a small sheet of platinum, immersed in distilled water; balance its electric potential through an ordinary galvanometer by that of a precisely similar couple composed of portions of the same specimens of the same metals, immersed the same moment as the other pair in a separate quantity of the same water; and gradually add to one of the two cells sufficiently small and known quantities of an adequately weak solution of known strength in a portion of the same water of the substance to be used, until the balance is upset, and take note of the proportions of the substance and of water then contained in that cell. It is more easy to successively dilute than to successively strengthen the solutions, and thus arrive at the "minimum point." The method is a little less accurate than the one in which the thermo-pile is employed.

By means of this method, using a couple composed of magnesium-platinum in distilled water, I have found the following "Minimum Points of Change of Voltaic Potential" in solutions of potassic chloride, potassic chlorate, hydrochloric acid, and chlorine. I selected these substances because they were representative ones, suitable to yield results for comparison, and because they gave extreme and intermediate magnitudes of the effect. The results are compared with those obtained with a Mg+Pt couple and the thermo-pile.

Potassic Chloride, KCl.

Solution at 18° C.; "minimum point" lay between 1 part in 3875 and 4650 parts of water; and by the aid of the thermo-pile, with the solution at 17° C., "minimum point" between 1 in 3875 and 4305.

Potassic Chlorate, $KClO_3$.

Solution at 19° C.; "minimum point" between 1 in 4650 and 5166; and with the pile, solution at 18° C., between 1 in 4920 and 5470.

Hydrochloric Acid, HCl.

Solution at 17° C.; "minimum point" between 1 in 516,666 and 664,285; and by the aid of the pile, solution at 19° C., between 1 in 516,666 and 574,074.

Chlorine, Cl.

Solution at 18° C.; "minimum point" between 1 in 15,656,500,000 and 19,565,210,000; and with the pile, solution at 12·5° C., between 1 in 17,000 millions and 17,612 millions.

These results show the great degree of delicacy of each method, and the extremely large difference of proportion of different substances required to upset the balance. The two methods agree.

By employing a great variety of dissolved substances I have found that nearly every such substance has a minimum proportion, below which it has no apparent effect upon the electromotive force of a MgPt or ZnPt couple in distilled water; and this proportion appears to be a constant number dependent only upon very simple conditions, viz., unchanging composition of the voltaic couple and liquid, a uniform temperature, and employing the same galvanometer. The apparently constant numbers thus obtained may probably be used as tests of the purity or of the uniformity of composition of dissolved substances.

The "minimum point" and degree of sensitiveness varies with—1st, the chemical composition of the liquid; 2nd, the kind of positive metal; 3rd, to a less degree with the kind of negative metal; 4th, the temperature at the surface of the positive metal, and at that of the negative one; and 5th, with the kind of galvanometer employed.

The order of the degree of sensitiveness or magnitude of the "minimum point" is manifestly related to that of degree of chemical energy of the liquid, and therefore also to the atomic and molecular weights of the dissolved substances, and to the ordinary chemical groups of halogens. With certain exceptions it is also distinctly related to the amounts of chemical heat. The greater the degree of free chemical energy of the dissolved substance, and the greater its action upon the positive metal, the smaller the proportion of it required to upset the balance. The proportion necessary for this purpose probably represents

* Read before the Royal Society, June 14, 1888.

a fixed amount of voltaic energy in all cases, viz., the amount necessary to overcome the mechanical inertia of the needle of the particular galvanometer employed.

As the "minimum point" of a chemically active substance dissolved in water is usually much altered by adding almost any soluble substance to the mixture, measurements of that point in a number of liquids at a given temperature, with the same voltaic pair and galvanometer, will probably throw some light upon the state of combination and degree of chemical freedom of substances dissolved in water.

ON THE

ACTION OF PHOSPHORUS PENTACHLORIDE ON ACETANILIDE.

By ARTHUR MICHAEL.

The investigations of Gerhardt* and Wallach† on the action of phosphorus pentachloride on anilides and alkyl amides have shown that the oxygen of the carbonyl is replaced by chlorine, but that these compounds are not very stable, and decompose into compounds having the general constitution R—CClNR and chlorhydric acid. Wallach, to whom we are principally indebted for the investigation of these interesting reactions, found that even the secondary products of the reaction are not stable in the heat, but pass over into basic substances free of chlorine. The investigation of the action of phosphorus pentachloride on the aromatic ethers of acetic acid led me to believe that an analogous reaction might be realised by the action of the pentachloride on anilides, and I made a few experiments with acetanilide in that direction, which, although they have not resulted in the synthesis of the anticipated class of substances, are not without interest. Forty-eight grms. of pentachloride (3 mols.) were brought into a flask connected with a condenser, cooled with ice, and ten grms. of powdered acetanilide (1 mol.) added. After the reaction that takes place in the cold, when, as Wallach has shown, the compound $CH_3—CClNC_6H_5$ is formed, the flask was allowed to stand at the ordinary temperature as long as chlorhydric acid came off, and the reaction was then completed by heating on a water-bath. The homogeneous mass—all the pentachloride was used up—was poured into water, when an oily mass remained undissolved that soon solidified. This substance was purified by crystallising from alcohol, and gave the following figures on analysis:—

0·2458 grm. substance gave 0·4258 grm. CO_2 and 0·0804 grm. H_2O.

0·2490 grm. substance gave 0·3525 grm. AgCl.

0·2734 grm. substance gave 0·3827 grm. AgCl.

	Theory for $C_8H_9Cl_2N_2$.	Found.		
C.. ..	47·29	47·24		
H . ..	3·94	4·21		
Cl . ..	34·97	—	34·94	34·64

The substance crystallises from alcohol in large white monoclinic prisms that melt undecomposed at 116·5°—117°. It sublimes slowly at 100°, forming small prisms with truncated end-faces. In water, cold and hot, it is insoluble, very soluble in warm, fairly in cold alcohol.

The substance has neutral properties, it being insoluble in acids as well as alkalies.

The action of pentachloride on acetanilide gives an entirely different result if, instead of heating on a water-bath, the mixture is allowed to remain in a moderately warm place for a long time. The mixture of pentachloride and anilide, in the same proportions as in the preceding experiment, was first cooled off on ice, and then allowed to stand at a temperature of about 35° for a week, when the greater part of the pentachloride was decomposed. It was noticed that after a number of days a yellow crystalline substance began to separate from the clear supernatant liquid. The contents of the flask were poured into water, and the insoluble residue purified by four crystallisations from alcohol.

I. 0·2621 grm. substance gave 0·5522 grm. CO_2 and 0·107 grm. H_2O.

II. 0·2482 grm. substance gave 0·5251 grm. CO_2 and 0·1029 grm. H_2O.

III. 0·2534 grm. substance gave 0·3172 grm. AgCl.

IV. 0·2015 grm. substance gave 0·2529 grm. AgCl.

	Theory for $C_{38}H_{33}Cl_7N_4$.	Found.			
		I.	II.	III.	IV.
C.. ..	57·32	57·47	57·54		
H.. ..	4·56	4·54	4·60		
Cl . ..	31·00	—	—	30·96	31·03

The compound forms concentric groups of long lemon-coloured needles that melt at 227° to 229°, but begin to darken at 210°. It is insoluble in hot water, benzene, and ether, moderately soluble in hot chloroform, readily in glacial acetic acid and hot alcohol, pretty soluble in cold alcohol. Like the preceding compound, it is insoluble in acids and alkalies.

It would be useless to speculate on the constitution of these substances until a more detailed investigation of their behaviour towards reagents has been made. The research will be continued in this direction, and it is also proposed to examine other anilides, as well as alkyl amides, in a similar manner.—*American Chemical Journal*, Vol. ix., No. 3.

RECENT INVESTIGATIONS ON THE FULMINATES.

By H. N. WARREN, Research Analyst.

The exact nature or formulæ of fulminic acid and its compounds, owing to their extreme unstableness, even to the present time, is, comparatively speaking, little known. The following experiments lately performed with these bodies, although possessed of scientific interest only, offer further contributions to our knowledge of them.

On account of the extremely dangerous nature of the fulminates necessitating the use of so small a quantity when examining their different reactions, some slight doubt naturally arises as to their exact nature. The salt used to conduct the experiments with was argentic fulminate (ordinarily fulminating silver). This being dissolved in hot water, and digested with copper filings, was transformed into cupric fulminate; the green salt obtained was dissolved in water and introduced into a tube open at either end, one extremity being closed by means of a porous diaphragm. The salt was reduced by means of nascent hydrogen, according to the usual method, namely, by connecting the same with a small Daniell's cell, the inside of the tube being provided with a platinum electrode connected with the negative end of the battery. In the course of a few hours the whole of the copper had become reduced to the metallic form, and firmly attached to the platinum plate.

The solution obtained, being thus freed from copper, was next examined, and was found to contain—besides large quantities of hydrocyanic acid and ammonia—distinct quantities of fulminic acid, evidently existing as ammonium fulminate. This was obtained and examined as fulminating silver, by digesting the same with argentic carbonate. In every instance an explosive fulminate was re-formed, corresponding to the normal fulminate.

In the next experiment cupro-ammonium fulminate was obtained by the addition of an excess of ammonia to a

* *Ann. Ch. et Phys.* [3], liii., 302.
† *Annalen der Chemie*, clxxxiv., 1; ccxiv., 193, 257

solution of cupric fulminate. The deep blue crystals thus formed were, after being dried by suspending them over sulphuric acid, decomposed by dry sulphuretted hydrogen. The product consisted, however, chiefly of copper sulphide, with urea and ammonium sulphocyanide.

Further, an attempt was made to combine fulminic acid with the element silicon, by passing a stream of dry silicon fluoride over argentic fulminate, kept moist by means of petroleum. Large quantities of argentic fluoride were at once formed, and the escaping gas—when collected and examined by introducing a light to the same—exploded with considerable violence.

Although the results obtained from several experiments performed by the same method agree with each other identically, it still remains an open question whether such a compound as silicon fulminate does in reality exist.

Chlorine, iodine, and bromine were also used, but chiefly gave rise to the substance known as chloropicrin and other bodies of an allied formula.

Experiments were also performed with the view of obtaining an ethyl compound, but these require further investigation before speaking definitely of them.

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INVESTIGATIONS ON THE OXIDATION OF SEWAGE.*

By J. H. LONG.

Something over a year ago I began a series of experiments for the Illinois State Board of Health, intended to show the rate of oxidation or destruction of sewage in a canal flowing west from the city of Chicago, and discharging finally into the Illinois river.

The peculiar situation of Chicago and its system of drainage dependent on this make such tests unusually interesting, and I wish, in the following, to present some of the results obtained in the work.

Only a few miles south and west of the city is found the low watershed separating the basin of Lake Michigan from that of the Mississippi. On the Chicago side of this "divide" is the Chicago river, mostly within the city limits, which serves as a harbour for shipping, and likewise as a receptacle for the greater part of the sewage from a population of about 800,000.

Many years ago the Illinois and Michigan Canal was constructed, connecting Lake Michigan through the river with the Illinois river at a point about 48 miles south-west of the city. This canal is supplied with water by pumps located at Bridgeport, within the city limits, five miles from the lake, which at present lift about 50,000 cubic feet per minute and discharge it toward the west.

The canal, then, at its eastern end, is fed by dilute sewage, and it is the changes in this that I have to explain.

This dilute sewage is made up chiefly of three elements :—

1. Of the water of Lake Michigan. This water contains in parts per million 136 parts of total solids, and furnishes of free ammonia from 0 to 0·01 part per million, and of albumenoid ammonia 0·070 part per million. In oxidation by the Kubel process, about one part per million of oxygen is required.

2. Of about 70,000,000 gallons per day of sewage proper. We have no accurate data showing the average composition of this as it leaves the sewers, but samples taken near the mouths of some of these showed large amounts of free ammonia, indicating an advanced stage of decomposition.

3. Of about 7,000,000 gallons daily of sewage from the large stockyards south of the city. The character of this has been investigated. In samples analysed last autumn I found the solid matter to amount to about 9200 parts per million, with between 3000 and 4000 parts of organic matter. Samples were taken every hour through the twenty-four, mixed and analysed, after dilution with pure water. In this way I found for one day, October 29th, in parts per million :—

Free ammonia	42
Albumenoid ammonia	6·4
Oxygen consumed.	208

The results obtained on other days averaged about the same.

Collection and Analysis of Samples.

The waters were taken in gallon jugs on the same day at the several stations, and sent to me by express. They were examined as soon as possible after their receipt.

After necessary dilution with pure water I determined free and albumenoid ammonia, taking precautions to make these experiments as accurate and uniform as practicable. I also found the consumption of oxygen by the Kubel process. Full details of the several methods, as followed, were given in my reports to the State Board of Health last winter, which, however, are not yet published.

The Water at Bridgeport.

Ten analyses were made of the water just as it reached the pumps. The first tests were made on water taken on June 26th, 1886, and the last on water taken on August 28th, with results as follows :—

	In 1,000,000 Parts.		
	Free Ammonia.	Alb. Ammonia.	Oxygen consumed.
June 26	2·6	0·64	12·0
July 3	2·7	0·52	6·8
„ 10	4·2	0·62	16·8
„ 17	25·0	1·50	22·4
„ 24	5·5	0·37	12·6
„ 31	23·0	1·76	23·2
Aug. 7	26·0	1·50	16·8
„ 14	29·0	1·64	32·0
„ 21	27·2	1·50	28·0
„ 28	29·2	1·90	35·2
Mean..	17·44	1·195	20·58

The smaller amounts of contamination in the first tests can be accounted for by the fact of a high lake level, in consequence of which the sewage outflow from the stockyards' sewer and other sewers was at times much retarded, and a comparatively clean water reached the pumps from the lake.

The Water at Lockport.

After leaving the pumps, the water flows along the level to Lockport, 29 miles below, requiring about a day for its passage. The canal water receives no additions between the two places, that is, it is not diluted by any other stream or feeder. The rainfall during the summer

The tests gave :—

	In 1,000,000 Parts.		
	Free Ammonia.	Alb. Ammonia.	Oxygen consumed.
June 26	2·8	0·56	11·36
July 3	2·4	0·42	7·2
„ 10	—	—	—
„ 17	10·2	0·72	12·8
„ 24	9·2	0·47	14·8
„ 31	11·0	0·72	10·7
Aug. 7	12·0	0·48	9·6
„ 14	15·2	0·88	9·76
„ 21	15·0	0·84	10·8
„ 28	13·0	0·88	12·4
Sept. 4	11·5	0·72	13·6
Mean..	10·23	0·669	11·30

* *American Chemical Journal*, Vol. x., No. 1.

of 1886 was unusually small; in fact, the lowest in 15 years. Dilution from this source can be left quite out of consideration, and owing to the frequent passage of propellers and other boats, no very great change in the character of the water by sedimentation could take place.

The Water at Joliet.

After passing Lockport, the water descends to Joliet through four locks, and falls over a dam seven feet in height, to point of collection. There is a fall of 58·2 feet in a distance of four miles, and no dilution takes place on the way.

The tests gave results as follows:—

	In 1,000,000 Parts.		
	Free Ammonia.	Alb Ammonia.	Oxygen consumed.
June 26	1·7	0·46	7·36
July 3	1·8	0·46	9·76
„ 10	2·4	0·56	9·20
„ 17	13·0	0·44	14·50
„ 24	—	—	—
„ 31	9·2	0·44	5·68
Aug. 7	7·5	0·42	5·84
„ 14	9·8	0·46	5·76
„ 21	9·0	0·112	0·520
„ 28	8·0	0·32	6·80
Mean..	6·93	0·408	7·79

Although there are certain irregularities in the above table which cannot now be explained, a general decrease of organic matter is plainly shown; and it will also be noticed that the percentage of loss per mile is much greater between Joliet and Lockport than between the latter and Bridgeport. This is undoubtedly due to the more perfect aëration of the water secured by the passage through the locks and over the dam.

The loss per mile is this, expressed in terms of amount at upper station:—

	Free Am.	Alb. Am.	Oxygen used.
Bridgeport to Lockport.	1·44 p.c.	1·52 p.c.	1·55 p.c.
Lockport to Joliet.. ..	8·06 „	9·75 „	7·76 „

Thus the loss of free ammonia per mile between Bridgeport and Lockport is 1·44 per cent of the amount at Bridgeport, while the loss between Lockport and Joliet is 8·06 per cent of the amount at Lockport.

Through a good part of its course the canal flows parallel to the Des Plaines river, which, 48 miles below Bridgeport, unites with the Kankakee to form the Illinois, into which also a large portion of the canal water is diverted.

The next tests were made at Ottawa, 48 miles below Joliet and 73 feet lower. The Fox river joins the Illinois at this point, so that the canal water becomes very much diluted. From surveys and measurements made recently it has been estimated by Mr. L. E. Cooley, of the Chicago Drainage and Water Supply Commission, that at the period under investigation—the summer of 1886—43 per cent of the water at this point came from the canal, and the rest from the streams named.

The chemical tests gave:—

	In 1,000,000 Parts.		
	Free Ammonia.	Alb. Ammonia.	Oxygen consumed.
June 26	0·50	0·23	7·05
July 3	0·104	0·21	0·576
„ 10	0·22	0·164	4·96
„ 17	0·56	0·252	6·54
„ 24	—	—	—
„ 31	0·49	0·250	6·00
Aug. 7	0·52	0·32	6·40
„ 14	0·30	0·144	4·80
„ 21	—	—	—
„ 28	0·36	0·33	3·12
Mean..	0·382	0·237	5·57

These figures show a remarkable decrease in the free ammonia, the loss amounting to 94·5 per cent of the quantity at Joliet. This is partly accounted for by the large dilution, as 57 per cent of the water here comes from sources other than the canal, as explained; but, unfortunately, it is not possible to express numerically the effect of this dilution, as we do not know the exact composition of diluting waters.

At first sight it would appear that, taking into consideration the amount of dilution, instead of there being a loss of albumenoid ammonia and oxygen consumed, there is a gain in this flow of 48 miles. This apparent anomaly can be explained, I think, without great difficulty.

The streams feeding the Illinois flow through a rich soil and partly swampy regions, where relatively large quantities of organic matter are taken up. The Sangamon river in this State is in some respects analogous to the Kankakee. I analysed a sample of its water, taken at Decatur, in the summer of 1885, and found it very highly contaminated with vegetable matter, partly suspended and partly in solution. The organic matter dissolved amounted to about 40 parts per 1,000,000, and other tests gave in parts per 1,000,000:—

Free ammonia	0·013
Alb. ammonia	0·170

I have no doubt that the river water at Ottawa, free from sewage, would show as large an amount of nitrogenous matter as these figures indicate.

It must also be remembered that the sewage of several towns enters the river above Ottawa. Joliet, which is sewered pretty completely, has a population of 15,000, while the other sewered places may have 5000 more. It is fair, then, to believe that a moderate change in the amount of organic matter has occurred between the two stations. The probability of such change is shown by the determinations made at Peoria, 78 miles below Ottawa, but at a lower level of only 15·5 feet.

There are no tributaries of any consequence between these cities. The proportion of canal water is decreased only from 43 per cent to 39 per cent, while sewage from several important towns is taken up.

It may also be added that the total flow at Peoria amounted to about 125,000 cubic feet per minute at the time of the tests, while about 22 days were required for the descent from Ottawa.

The tests gave:—

	In 1,000,000 Parts.		
	Free Ammonia.	Alb. Ammonia.	Oxygen consumed.
June 26	0·036	0·150	5·04
July 3	—	—	—
„ 10	0·084	0·150	5·04
„ 17	—	—	—
„ 24	—	—	—
„ 31	0·0048	0·196	4·64
Aug. 7	0·0072	0·210	6·80
„ 14	0·042	0·190	4·72
„ 21	0·066	0·212	4·88
.. .. ..	0·009	0·206	2·80
Mean..	0·0355	0·1877	4·85

Unfortunately, there are three breaks in this table due to the neglect of the persons expected to forward the water. The tests carried out showed, as at Ottawa, a marked loss of free ammonia, which must be explained chiefly by oxidation. There is likewise a perceptible diminution in the amount of oxygen consumed and in the albumenoid ammonia, even after the dilution is taken into consideration.

It is plain that in this long stretch of 78 miles with a fall of only 15 feet the water must be in many places practically stagnant, and we know that under such circumstances oxidation of organic matter is necessarily slow. The conversion of ammonia into nitrates is

apparently much more rapid. It is possibly true that the residual organic matter, represented by the oxygen consumption and albumenoid ammonia, is of a relatively stable type, capable of resisting complete change for a long period, but which may be broken up with comparative ease by the reagents of the laboratory processes. Many of the vegetable matters, finding their way into these waters, are of that nature, as numerous experiments have shown.

It must also be borne in mind, as mentioned above, that a certain amount of sewage is discharged into this portion of the river, and taking all these points into consideration, it is fair to conclude that destruction of organic matter is going on here at a moderate rate, but less rapidly than above.

It would be interesting to know the condition of affairs in the stream between Peoria and its junction with the Mississippi, a distance of some 200 miles. An investigation of this nature is contemplated for the near future.

The above tests show in a fair and unmistakable way the general fact of the gradual purification of a highly contaminated water by what may be broadly termed oxidation. In the upper part of the course sedimentation cannot be called into account for much of this change, as the water undergoes frequent agitation by passing boats. In the lower part of the course this disturbance is less frequent, but at the same time the matter which could be lost by sedimentation is less abundant.

I am therefore led to attach considerable importance to these investigations, as showing pretty fully the rate at which a city's sewage is destroyed under certain conditions of temperature, dilution, and velocity of flow. In most similar investigations these important data are given imperfectly or not at all, so that to draw a legitimate conclusion is almost impossible.

Oxidation in Winter.

It is generally admitted that destruction of sewage is less rapid in winter than in summer, although direct chemical experiments bearing on that point are very few.

During last winter the above investigations were continued so as to show as nearly as possible just what the effect of the cold really is. The waters were taken at the same places by the same observers and examined in the same way. The results of these examinations are given in the accompanying table—the results expressed in parts per 1,000,000.

In this table there are many perplexing irregularities, some of which can be explained, while for others the data are lacking.

On the 7th of December, owing to an accident, pumping was stopped at Bridgeport, and did not begin again until December 27th. During this time the flow under the ice through the canal amounted to about 15,000 cubic feet per minute by gravity, while the flow in the small rivers below was likewise lessened. After December 27th the pumps forced about 50,000 cubic feet per minute through the winter.

In January there is shown a decrease in the free ammonia with an increased amount of albumenoid ammonia and oxygen consumed at Bridgeport and Joliet, as compared with the summer rate, while at Ottawa and Peoria all these factors are increased. After the close of navigation sedimentation plays an important part in the still water. For this reason purification appears more rapid than is actually the case.

Near the source of contamination we can understand that free ammonia is not so quickly formed, because of the low temperature; and for the same reason, when once formed, it is not so readily oxidised at points further down in the stream.

The effect of the stoppage of the pumps is shown in the albumenoid ammonia as late as January 8th at Ottawa. After this date, between Ottawa and Peoria there seems to be no change in the organic nitrogenous matter, the amount at the latter place being about twice as great as during the summer.

From	When taken.	Free Ammonia.	Albumenoid Ammonia.	Oxygen consumed.
Bridgeport ..	Dec. 18	17·60	4·80	28·8
,, ..	Jan. 18	6·60	3·50	16·0
,, ..	,, 29	5·90	3·80	22·4
,, ..	Feb. 3	10·60	3·70	32·8
Lockport. ..	Dec. 6	3·70	0·56	17·6
,, ..	Jan. 3	9·20	3·90	21·6
Joliet	Dec. 7	11·00	0·60	16·8
,, ...	,, 13	13·00	1·80	19·2
,, ...	,, 20	13·20	3·30	21·6
,, ...	,, 27	18·40	4·90	24·8
,, ...	Jan. 1	11·60	3·72	19·6
,, ...	,, 8	8·40	4·20	18·4
,, ...	,, 15	5·40	3·00	10·0
,, ...	,, 22	3·24	1·76	14·4
,, ...	,, 29	3·20	1·54	10·0
,, ...	Feb. 4	3·80	2·22	19·2
Ottawa	Dec. 9	1·52	0·54	10·4
,, ...	,, 13	5·74	2·60	15·2
,, ...	,, 22	6·80	1·20	11·2
,, ...	,, 28	0·96	2·92	*60·0
,, ...	Jan. 4	8·20	2·70	10·8
,, ...	,, 8	2·20	2·80	*44·0
,, ...	,, 22	2·60	0·30	6·8
,, ...	,, 29	0·36	0·32	†11·2
,, ...	Feb. 5	3·70	0·38	9·2
,, ...	,, 12	3·20	0·46	10·8
Peoria	Jan. 15	1·26	0·25	4·4
,, ...	,, 22	3·60	0·68	7·36
,, ...	,, 29	0·52	0·36	7·60
,, ...	Feb. 2	0·90	0·36	8·80
,, ...	,, 7	0·72	0·34	7·90

The waters collected at Peoria during the summer were without odour, while through the winter it was frequently quite marked. It is said to be very noticeable at holes broken in the ice, and if the filth left above by deposition reached here it would be much worse.

This state of the water can be partly accounted for by the diminished flow from some of the streams feeding the Illinois, but the chief factor is undoubtedly the low temperature. A coating of ice excludes the air, and thus prevents direct oxidation when this is possible. A more important result of lower temperature is found in the diminished activity of bacterial ferments. These are probably the chief agents in the decomposition of organic filth, and their efficiency is greatest at moderate temperatures.

The above experiments, while not as complete as could be desired, show several important points. Even under the unfavourable conditions in the canal and river, it is seen that sewage is pretty rapidly decomposed in summer. With a greater velocity of the flowing water this change would undoubtedly be much more complete.

The slow rate of winter change is clearly shown. These results suggest another very interesting inquiry, viz., At what rate is *rapidly moving* sewage oxidised in winter? An answer to this, with statement of all conditions, would have a great practical value.

Action of Calcium Carbonate upon Cadmium Chloride, Bromide, and Iodide.—A. de Schulten.—With cadmium chloride the product formed is a compound of cadmium hydroxide and of the chloride of the same metal. Or it may be regarded as a cadmium hydrochlorate or a chlorhydrine. With cadmium bromide the result is crystals of a basic bromide. With cadmium iodide no precipitate is obtained.—*Comptes Rendus*, Vol. cvi., No. 24.

* Very unusual colour and odour.

† This sample was taken on January 29, but not forwarded until a week later.

PROCEEDINGS OF SOCIETIES.

ROYAL SOCIETY OF CANADA.

THE Royal Society of Canada met at Ottawa, May 22nd to 25th, under the presidency of GEORGE LAWSON, M.A., Ph.D., LL.D., F.I.C., Professor of Chemistry, Dalhousie College, Halifax.

Fifty-six papers were read in the several sections, viz. :—I. Littérature Française, &c., fourteen; II. English Literature and History, twelve; III. Mathematical, Physical, and Chemical Sciences, nine; IV. Geological and Biological Sciences, twenty-one.

The President's Address referred specially to the importance of systematic tidal and current observations in Dominion waters, the scientific federation of the Empire, the International Geological Congress, the formation of a scientific library, and the scientific and literary work of the Members during the past year, a summary of which was given.

A Farewell Address was presented to His Excellency Lord Lansdowne, the Governor General, and the Marquis of Lorne was requested to represent the Society at the approaching eight-hundredth anniversary of the University of Bologna.

The following papers of interest to chemists were read :—

"*A Table of the Cubical Expansions of Solids.*" By Prof. J. G. MACGREGOR, M.A., D.Sc.

This paper contained a collection of the constants determining the thermal expansion of all the more important and interesting solids, with reference to the scientific memoirs from which they have been derived. These constants are the values of a, b, c, in the equation :—

$$V_t = V_0 (1 + at + bt^2 + ct^3)$$

which has been found capable of expressing the volume (V_t) of a body, at a temperature t, in terms of its volume (V_0) at 0° C., and of t. These constants being known, the mean coefficient of thermal expansion for any range of temperature within the temperature limits of the experiments by which the constants were determined, and the true coefficient at any temperature within the same limits, may be found without difficulty. Similar tables, formerly published, such as that of Prof. Clarke in his "Constants of Nature" (published by the Smithsonian Institution), give merely the values of the mean coefficients for given temperature ranges, thus embodying only a small portion of our knowledge of the expansion of solids.

"*The Foundations of Chemistry.*" By T. STERRY HUNT, LL.D., F.R.S.

"*The Classification and Nomenclature of Metalline Species.*" By T. STERRY HUNT, LL.D., F.R.S.

The author recalls his essay on "A Natural System in Mineralogy," presented in 1885, and published in Volume III. of the *Transactions of the Royal Society of Canada*, wherein he discussed the grounds and principles of a true natural system of Classification, and exemplified them by an extended study of the order of Silicates. It was then proposed to divide the mineral kingdom, for natural historical purposes, into four classes, including respectively the metalline, the oxidised, the haloid, and the pyricaustate or combustible species, of which the first, third, and fourth classes included only one order each, the second embracing seventeen orders. Adopting a Latin terminology, the first class becomes the METALLACEÆ, including the order of the METALLATES, which are divided into two sub-orders, the *Metallometallinea* and the *Spathometallinea*, based on the fundamental difference recognised by all naturalists between the group of the Glances and that of the Blendes. The author then proceeds to show the reason for including in the same order with these the group of the pyrites and the native metals, and arranges all these in nine tribes, based alike on chemical and on physical grounds.

Preparatory to this, however, the relations between hardness and specific gravity on the one hand and chemical equivalent on the other are next discussed, it being maintained that these physical characters vary with the condensation of the species, or, in other words, are functions of the integral or so-called molecular weight, which is at the same time the density of the species; that of hydrogen gas at 100 being unity. The weight of a given volume of this being known, that of the same volume of any other species, whether gaseous, liquid, or solid, is truly its equivalent weight. It is then shown that hydrogen gas at standard temperature and pressure being H 2 = 20, water vapour, H_2O, is 17·96; and liquid water 1192 (H_2O) = 21408, or in round numbers 21400, which, being that of a body whose specific gravity is assumed as unity, enables us to calculate the integral or equivalent weight of all species compared with it. It follows that the integral weights of solid and liquid species are very elevated, and that these are highly condensed on polymene bodies whose coefficient of condensation is determined by comparing their empirical combining weight deduced from chemical analysis with that calculated from their specific gravity, water being unity. The value got by dividing this empirical weight by the specific gravity—$p \div d = v$, or the so-called atomic volume, is the reciprocal of the coefficient of condensation, and, as long since pointed out by the author, the hardness and chemical indifference of related species are inversely as the value of v. In calculating this value, as already shown in 1885, the unit for p in metalline species is for convenience made the mean quantivalent weight; that is to say, it is the number got by dividing the empirical weight as deduced from the chemical formula by the sum of the equivalents therein represented, so that marcasite $FeS_2 = 120$, we divide by six and find $p = 20$, and for stibnite, $Sb_2S_3 = 336$, we divide by ten and find $p = 33·6$.

Order Metallates.

Sub-order A.—METALLOMETALLINEA.

Tribe 1. *Metalloidæ* (various metals and alloys).

Tribe 2. *Galenoideæ* (divided into three sub-tribes).
- *a.* Thiogalenoideæ, gen. Thionites, Thiophyllites.
- *b.* Selenogalenoideæ, gen. Eucairites.
- *c.* Tellurogalenoideæ, gen. Tellurites, Tellurophyllites.

Tribe 3. Bournonoideæ, gen. Bournonites, Empleitites.

Tribe 4. Leucopyritoideæ, gen. Leucopyrites, Algoodonites.

Tribe 5. *Arsenopyritoideæ*, gen. Arsenopyrites.

Tribe 6. *Pyritoideæ*, gen. Pyrites, Pyritinus.

Sub-order B.—SPATHOMETALLINEA.

Tribe 7. *Spathometalloideæ* (sulphur, selenium, phosphorus.

Tribe 8. *Sphaleroideæ*, gen. Sphalerites, Sandaraca.

Tribe 9. *Proustoideæ*, gen. Pyrargyrites, Termantites.

The Metalloideæ, including alike the native metals and those artificially got, present great differences of hardness and density, as well as in the value of v and in other characters, and must be grouped in several genera or subgenera. The Galenoideæ are conveniently divided into three sub-tribes of sulphides, selenides, and tellurides. The first or Thiogalenoideæ (H = 2—3 : v = 7—8) includes the typical genus Thionites, embracing the native sulphides of silver, lead, and copper, together with metacinnabar, stibnite, and bismuthite. (H = 2—3 : v = 7—8) includes the typical genus Thionites. The second, or Selenogalenoideæ, (H = 2—3 : v = 8—9·5), embracing the various selenides of silver, lead, copper, mercury, &c., of which encairite may be taken as a type. The third, or Tellurogalenoideæ, includes the genus *Tellurites*, comprising the tellurides of silver, gold, lead, mercury, bismuth, and nickel—

(H = 2·5—3·5 : v = 9·5—10·5).

The soft flexible foliated sulphides, like sternbergite, argyropyrite, firesite, argentopyrite, and molybdenite, may constitute a genus.

Thiophyllites and tetradymite and nuggagite belong to another genus, *Tellurophyllites*.

The tribe Bournonoideæ includes the large genus *Bournonites* ($H=2—3·5 : v=7·5—8$), consisting of double sulphides of antimony with lead, silver, and copper, of which bournonite is a familiar example. The species of this genus present instructive examples of progressive series, especially those represented by $Sb_2S_3 \cdot nPbS$, in which n has values of 1, 2, 3, 4, 5, 6, and in a related species, of 12. The large group of double sulphides of bismuth, having similar values for H and v, of which empleitite may be taken as an example, constitutes the genus *Empleitites*.

The tribe Leucopyritoideæ, embracing various arsenides and antimonides, includes the genus *Leucopyrites*—

$$(H=5—6 : v=4·5—5·5),$$

made up of arsenides of iron, nickel, and cobalt, of which leucopyrite and smaltite are types, while the antimonial species breithauptite is closely related. The arsenides of copper, with less hardness and a higher value of v, will form another genus *Algodonites*, near to which is the antimonide of copper, horsfordite, and the antimonial silver, dyscrasite.

The Arsenopyritoideæ include the genus *Arsenopyrites* ($H=5—6 : v=4·5—5·5$), embracing the double sulphides of arsenic, with iron, cobalt, nickel, of which mispickel or arsenopyrite is a type. Closely related thereto are double sulphides, including antimony and bismuth, of which ullmannite, corynite, alloclasite, and gmuanite are examples.

The Pyritoideæ include two principal genera—*Pyrites* ($H=5·5—6·5 : v=4—4·5$), comprising sulphides of iron, cobalt, nickel, copper, chromium, and ruthenium; and *Pyritinus* ($H=3·5—4·0 : v=4·7—5·5$), also of sulphides of iron, nickel, copper, with manganese and tin.

In the Spathometalloideæ are comprised the various forms of sulphur, selenium, and phosphorus. The Sphaleroideæ include the genus *Sphalerites*—

$$(H=2·5—4·0 : v=6—7),$$

embracing sphalerite, wurtzite, greenockite, hauerite, oldhamite, and cinnabar. Here also probably belongs the red antimonic sulphide. The soft arsenical sulphides, realgar and orpiment, may perhaps form a distinct genus *Sandaraca*, to which cinnabar seems nearly related. The Proustoideæ include the genus *Pyrargyrites*—

$$(H=2—3 : v=8—9),$$

in which we place both arsenical and antimonial red silver ores—proustite, pyrargyrite, miargyrite, polybasite, &c. In this tribe also is placed *Tennantites*—

$$(H=3·5—4·5 : v=6·5—7·5),$$

including the various species of fahlerz, with bismite, dufrenoysite, livingstonite, &c.

Sphalerites	zinceus vulgaris	Sphalerite
,,	zinceus hexagonus	Wurtzite
,,	cadmeus	Greenockite
,,	ferrozinceus	Christophite
,,	manganeus.	Panerite
,,	calcareus	Oldhamite
Pyrites	cubicus	Pyrite
,,	prismaticus	Marcasite
,,	cobalteus..	Linnaeite
,,	niccolocobalteus	Seigenite
,,	cuprocobalteus.	Carrollite
,,	rutheneus	Lawrite
Pyritinus	magneticus	Pyrrhotite
,,	ferrosus	Troilite
,,	manganosus	Alabandite
,,	cupreus	Chalcopyrite
,,	subcupreus	Cubanite
,,	supercupreus.	Barnhardtite
,,	niccolosus	Millerite
,,	niccoloferrosus	Pentlandite
,,	subniccolosus	Polydmite
,,	stannorus	Stannipyrite

The hardness (H) and the value of v have here been given approximately. The paper presented includes all the species of this order, tables giving the chemical formulæ, crystalline forms, hardness, specific gravity, and the calculated value of p and v, besides a binomial Latin nomenclature, of which examples are here given from three genera.

"*Notes on Nova Scotia Gold Mines.*" By E. Gilpin, Jun., M.A., F.G.S.

The writer describes briefly the conditions under which the auriferous veins of Nova Scotia occur. The filling of the veins formed by the process of folding the strata have undergone was apparently continuous and contemporaneous. The relation of the granites intimately connected with the auriferous strata has apparently not influenced their value. The "pay streaks," or richest zones of the veins, are described, as well as the "low grade" ores. Reference is made to the question of lower or second pay streaks, and the local conditions of accumulation of gold from the associated beds of slate instanced as differing from the opportunities for repeated pay streaks in true or cross-country veins.

NOTICES OF BOOKS.

Twelfth Annual Report of Her Majesty's Inspectors of Explosives: being their Annual Report for the Year 1877. London: Her Majesty's Stationery Office.

The General Law on Explosives has received, during the past year, a very necessary amendment. Heretofore picric acid, its salts, and mixtures containing such acid or salts have been held as explosives, and have come within the purview of the Inspectors only when they were manufactured for military, engineering, or pyrotechnical purposes. If made for the use of the painter, dyer, or colour manufacturer they were exempt from control, though, of course, no less dangerous than if prepared with any other object. It is now considered as an explosive and dealt with accordingly, except wholly in solution, or kept in some separate locality where it cannot under any circumstances come in contact with any substance capable of forming an explosive mixture or compound, or with any detonator, or with fire.

The Inspectors consider that the weak point in the Explosives Act is its careless administration by local authorities, though even in this respect there has been a decided improvement during the last few years.

The total number of factories under the Act is 108, though 105 only are in actual use.

Certain new explosives have been submitted for examination, viz., roburite, amide-powder, Borland's powder, carbo-dynamite, and victorite. All these were passed except the last, as also "Forti's explosive," which stood over from the previous year. "Quick-firing ammunition" is licensed only for Imperial service.

Cases of the illegal manufacture of fireworks are still brought to light from time to time, chiefly in consequence of accidents.

Chemists still compound "coloured fires" on their premises. It is noted that an offender of this kind in Edinburgh was fined only half-a-crown. Blasting cartridges are now less frequently made in private houses. It is very gratifying to learn that the workpeople in the factories are beginning to feel the value of the official regulations.

Prosecutions have been instituted only in two cases. Temporary seizures were made in seven cases, but the articles were returned on removal of the cause of complaint, along with an undertaking for their future evidence. During the year sixty-three accidents have occurred, involving eight deaths and eighteen cases of personal injury.

The total number of magazines is now 347, being a decrease of seven since 1886. A dynamite magazine near Burrow-in-Furness was broken into by thieves, a box opened and a quantity stolen, the rest being scattered about. There was no reason to suspect political motives. In two instances only have proceedings been found necessary. At a store in Ayrshire an officer of the Local Authority found five young mice in a packet of dynamite!

Spilling loose gunpowder in and about a store containing 400 lbs. of gunpowder, near Birmingham, led to an explosion in which four persons were killed, four more injured, and considerable damage was done to property. It is satisfactory to learn that several attempts at the illegal importation of explosives have been detected and frustrated.

The total number of accidents in factories, magazines, and stores has been 130, involving 43 deaths and injuries to 105 persons.

The impression left upon the mind, after a careful examination of this bulky report, is that the Inspectors do fully all that can be expected, unless they were more efficiently supported not merely by the local authorities, but by public sentiment.

Soaps and Candles. Edited by JAMES CAMERON, F.I.C. London: J. and A. Churchill.

THIS work forms one of the series of "Technological Handbooks" issued by Messrs. Churchill. There is no one who can be regarded as the author, the editor informing us in his Preface that the articles in Cooley's "Cyclopædia" have been added to from various scattered sources. He also expresses his obligations to Mr. L. Field, of Lambeth, and to Messrs. Cook, of the East London Soap Works.

Details of many analytical processes have been omitted as probably known to the student,—a very judicious step in a treatise which undertakes to discuss two such im portant arts as soap- and candle-making in less than 300 pages.

The first chapter, extending to 16 pages, is devoted to the definition, history, and properties of soap,—a subject, perhaps, scarcely in its right place in a technical treatise. What we may call the practical part of the work begins with a notice of the materials. The reader is, however, referred for details to a companion volume on "Oils and Varnishes."

"Recovered grease" from the waste waters of the woollen works cannot be pronounced fit for the manufacture of soaps, as it is never entirely freed from promiscuous dirt, not to speak of the unsaponifiable oils. It is much more in its right place as a material for the production of oil-gas.

Under "Sunflower-seed" we meet with the interesting remark, from the pen of Mr. Leopold Field, that "the *perfect* soap has yet to be made, and it will probably be made from sunflower oil." We have often wondered why the sunflower is not cultivated in this country on a commercial scale. It is quite a mistake to say that our climate is not sunny enough, since the plant owes its name not to its especial craving for sunshine, but to its resemblance to images of the sun as drawn by barbarous nations in their temples. But we should submit that the ideal soap, the soap of the future, will be an artificial bile, equal to natural ox-gall in its detergent and at the same time non-corrosive action, but free from its disagreeable odour. Will none of the great synthesists of the day take up this problem?

Mr. L. Field, in his Report of the Imperial Exhibition of 1886, here quoted, expresses the opinion that the delicacy and persistency of the scents of the French toilet soaps is in some measure due to the fact that French toilet-soap makers use bleached palm oil much more than their English rivals. For contact with the human body soaps from the vegetable oils are safer than those obtained from animal fats, which are always liable to be accompanied by traces of putrescent animal matter.

In speaking of the alkalies the author does not, so far as we can see, mention the facts that potash saponifies oils more readily than does soda, and that potash soaps are found very much preferable to soda soaps wherever they have to come in contact with wool or woollen goods. He mentions the "Natrona refined saponifier," and also the preparation of soap by the consumer from the caustic soda (or potash) sent out by the Greenbank Alkali Company of St. Helens.

Bauxite is here said to be an aluminate of iron, and has assigned to it the formula $(AlFe)_2O_5H_4$. This scarcely agrees with analytical results. One of the finest qualities of bauxite now in the market contains 59·37 per cent of alumina and only 0·58 of ferric oxide. This is an Irish sample. French qualities generally contain more iron. We should be more apt to regard bauxite as a dihydrated alumina, containing iron, lime, titanic acid, and silica as impurities.

It is to be remarked that whilst some makers recommend alumina, aluminates, and aluminium silicates as useful additions to soap, others regard alumina as an injurious matter (Way's specification).

The methods given for bleaching oils and fats are the bichromate process, the use of nitric acid, chlorine, or bleaching-powder, the hot-air process, and the caustic soda and steam method. We believe that in bleaching these important articles there is still room for future improvement.

We fully admit that this book may prove widely useful, but we doubt whether, on comparing it with the treatises of Carpenter (1885) and of Watt (1884), it constitutes any distinct step in advance.

Introductory Inorganic Analysis. A First Course of Chemical Testing. By ERNEST H. COOK, D.Sc. (Lond.), F.C.S. London: J. and A. Churchill.

WE have been surprised, but by no means disagreeably, at the first few words of the author's Preface. He writes:—"This little book, strange though it may seem, has not been written to meet the requirements of any examination." There is no little dry sarcastic humour in the words "strange though it may seem." He proceeds:—"But in as far as examinations are tests of sound knowledge, it is hoped that it will be found useful for all." It would seem, therefore, that Dr. Cook is alive to the truth, which we trust is becoming more generally recognised, that examinations are not the sum and substance of education, and that their value as tests of sound knowledge is limited.

The introductory precepts to be remembered by the student are very good. We notice in particular that each operation should be written down in the note-book in three parallel columns:—Experiment; Observation; Inference.

As a first step—and that is all to which it lays claim—it may be safely recommended.

CORRESPONDENCE.

ALUMINIUM IN IRON.

To the Editor of the Chemical News.

SIR,—In reply to the above query in CHEMICAL NEWS, vol. lvii., p. 240, the following lines may perhaps afford some information. It is of course impossible to lay down any precise method of chemical analysis before having first examined the sample in particular, but the following method has been successfully worked in my laboratory on alloys containing iron, aluminium, manganese, silicon, and phosphorus.

The alloy is decomposed by HCl or aqua regia, evaporated to dryness by the aid of the water-bath, in order to

separate the silicon, re-dissolved by HCl, the solution rendered as neutral as possible, and an excess of ammonium succinate added. This precipitates the whole of the iron and aluminium, together with the phosphorus that exists as phosphates. The amount of phosphorus is then determined in a separate portion, afterwards calculated to P_2O_5, and subtracted from the iron and alumina precipitates; the difference gives the $Al_2O_3+Fe_2O_3$ obtained. The amount of iron present is next determined volumetrically by the aid of standard potassium bichromate, and the result obtained subtracted from the Al+Fe gives the percentage of Al.—I am, &c.,

H. N. Warren.

Liverpool Research Laboratory,
18, Albion Street, Liverpool.

FRENCH TECHNICAL TERMS.

To the Editor of the Chemical News.

Sir,—In answer to your correspondent, "Chemicus," an ordinary French and English Dictionary should be studiously avoided for the meaning of technical terms generally. The cause of this literary *hiatus* is not far to seek; lexicographers are not scientific men, and unfortunately translators will even give to an italicised word a meaning quite alien to the idea it is intended to express. In scientific or technical works, where special terms are met with, it is best to consult "Littre's Dictionnaire," which may be found in any good library.—I am, &c.,

Thomas T. P. Bruce Warren.

Tamworth Villa, Earlham Grove,
Forest Gate, E., June 24, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of emperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 24, June 11, 1888.

Refrigerating Mixtures obtained with Solid Carbonic Acid.—L. Cailletet and E. Colardeau.—The authors show that in a mixture of flocculent carbonic acid and ether the latter does not, as commonly supposed, act merely by establishing a more complete contact with the body to be refrigerated, but that cold is produced by the solution of the carbonic acid in the ether. Solid carbonic acid alone produced a temperature of −60° under the ordinary atmospheric pressure, and of −76° in a vacuum. A mixture of solid carbonic acid and ether gave, under ordinary atmospheric pressure, a temperature of −77°, and in a vacuum of −103°. The experiment was repeated with other solvents. Methyl chloride and liquefied sulphurous acid gave each −82°, acetamylic ether −78°, phosphorus trichloride −76°, and absolute alcohol −72°. In a mixture of methyl chloride and solidified carbonic acid in a vacuum a temperature of −106° was observed.

The Artificial Reproduction of Hydrocerussite, the Chemical Composition of this Mineral, and on the Constitution of White-Lead.—L. Bourgeois.—Hydrocerussite is a very rare basic lead carbonate found in small quantities at Langban, in Sweden, and at Wanlockhead. Its composition has been assumed to be PbO,CO_2+PbHO (Nordenskiöld). The author having prepared this product artificially gives its composition as $3PbO,2CO_2HO$. He considers that the white-lead of commerce is a mixture of cerussite and hydrocerussite.

Measurement of the Speed of Etherification by Means of Electric Conductivities.—M. Negreano.—To this mathematical paper we can merely draw attention.

On the Azo-derivatives of Benzene.—P. Petit.—The author determines the formation-heats of the azo-compounds derived from benzene: azo-oxybenzol, azobenzol, hydrazobenzol, and also of phenylhydrazine, bodies which may be considered as reduction-products intermediate between nitrobenzol and aniline.

Thermic Formation of the Salts of the Phenylenediamines. Researches on Paraphenylene-diamine.—Leo Vignon.—The author measures the quantities of heat evolved by the union of acids with the three phenylenediamines. He describes also three new compounds of paraphenylene-diamine, a hydrate, a sulphate, and an oxalate.

On the Formation of Amido-butyric Acid by the Direct Fixation of Ammonia upon Crotonic Acid.—M. Engel.—Crotonic acid fixes the elements of ammonia at 100°, and with the greatest ease. The yield is almost theoretical. No secondary product appears to be formed except a little oxybutyric acid. The amido-product is an amido-butyric acid, and is very probably β-amido-butyric acid.

Zeitschrift fur Analytische Chemie.
Vol. xxvi., Part 6.

Dehydromorphine (Oxydimorphine, Pseudomorphine).—As distinctions of this base from morphine, Hesse points out that morphine dissolves in pure strong sulphuric acid with a very faint reddish colour; pseudomorphine is at first colourless, but the solution soon becomes yellowish and reddish. If the acid contains a trace of ferric oxide it gives with morphine a reddish solution, but the pseudomorphine a blue solution, soon becoming deep violet and finally brownish green.

Colorimetric Determination of Salicylic Acid with Ferric Chloride.—Frehse finds that the following conditions are essential:—The comparative solution of a known strength must be frequently renewed, as it undergoes a gradual decomposition. The salicylic acid must be extracted with ether, not examining feebly-coloured liquids directly as acids; alkalies and neutral phosphates, oxalates, and tartrates interfere or even prevent the reaction. The solution of ferric chloride must be very dilute.

Determination of Small Quantities of Paratoluidine in Orthotoluidine.—C. Hæussermann.—The author pours a solution of 88 grms. crystallised oxalic acid in 750 c.c. water and 43 c.c. hydrochloric acid at 22° Beaumé, heated to 70° to 80°, into a porcelain capsule. He adds 100 grms. of the toluidine in question, and heats, whilst stirring, until the oxalate is completely dissolved. The liquid is then let cool slowly, still stirring occasionally, until a just visible separation of oxalate appears on the surface, which may take place between 30° and 35°, according to the proportion of the para-compound. As soon as a small quantity has crystallised out, and there ensues a pause in the crystallisation (*e.g.*, after separation of 0·5 grm.), it is quickly filtered through an open linen cloth, the residue is washed with a few drops of water, and slightly pressed. If this first crystallisation has a dead white appearance, without lustre, the filtrate after standing for a short time is filtered again, yielding a mass almost equal to the former. The collection of the several separations is continued until there are obtained not dull scales, but crystalline masses with bright surfaces, consisting of pure ortho-oxalate, and which after sufficient experience can be clearly distinguished from the earlier deposits containing para-oxalate. When this point is reached the liquid, which is now perfectly free from the para-compound, is set aside. The crystalline fractions are now distilled successively with a solution of sodium carbonate, and the base, which passes over with the watery vapour, is first submitted to a qualitative test, *i.e.*, it is cooled with ice and examined as to its congealing-point. If the sample becomes solid on mere stirring, the crystalline mass is collected on a tared filter,

pressed slightly, dried over caustic soda, and weighed as pure paratoluidine. If it congeals only on contact with a crystal of pure paratoluidine, only half its weight is calculated as paratoluidine.

Detection of Spermaceti in Oil of Roses.—G. Heppe.—The author shakes up the sample with 1½ to 2 vols. of melted glacial acetic acid. In a few minutes the mixture congeals to crystals. The mass is thrown upon a small filter, and washed with water until the smell of roses has almost disappeared. It is then washed with solution of soda, and again with water. The insoluble portion consists of spermaceti.

Ethereal Oils.—For these methods for distinguishing essential oils we must refer to the original.

Separation of Magenta from the Colouring-matter of Orchil. — C. Schweissinger. — If 0·25 grm. of pure orchil colour is extracted with alcohol, evaporated, the residue taken up in 50 c.c. water, mixed with 10 c.c. basic lead acetate, and filtered immediately, there is obtained a coloured filtrate which gives up the colouring-matter to amylic alcohol. If it is allowed to stand half an hour the colouring-matter is entirely deposited. If magenta is present the filtrate from the lead precipitate is coloured. The detection of acid magenta (magenta S) in orchil extract is effected as follows :—A small quantity is boiled up with excess of water and filtered. The clear filtrate is mixed with benzaldehyde, then tin crystals and hydrochloric acid are added, the whole well shaken up and let stand. If acid magenta is present the lower stratum is red; if not, it is colourless.

Detection of Arsenic by Marsh's Process. — G. Buchner.—The formation of the arsenical mirror depends on temperature, and is accelerated by a strong heat. According to N. P. Hamberg arsenic is eliminated from putrescent animal matter in the form of hydrogen arsenide.

Recognition of Chloroform after Death.—C. Luedeking.—Chloroform may be detected in the lungs of animals four weeks after death.

Bulletin de la Société Chimique de Paris.
Vol. xlix., No. 1.

On the Speed of the Reaction of Iceland Spar with Acids.—W. Spring.—All the surfaces of cleavage dissolve equally quickly, all other conditions remaining alike. The lines showing the variation of the speed of the reaction for the temperatures of 15° and 35° are almost right lines after a yield of 50 and 75 c.c. of carbon dioxide, and up to about 350 c.c. But at the temperature of 55° it is no longer the same, that is, the speed declines more rapidly than the concentration. Iceland spar is attacked only very slowly in hydrochloric acid of 2 per cent. This is a result very different from that observed in marble, where the reaction continues to the complete exhaustion of the acid. At each temperature tried the dissolving speed of spar is smaller than that of marble.

The Proportion of Carbon and Hydrogen contained in Coal-schists. A Contribution to the Study of the Formation of Coal.—W. Spring.—The formation and preservation of a coal rich in gas can only have occurred when it was sufficiently protected against atmospheric agencies. The many varieties of coal owe their origin probably rather to the unequal manner in which they have been protected against slow combustion than to a difference in the kinds of vegetation from which they are derived. Even in our epoch the fattest coals give the most abundant escapes of "fire-damp." The presence of this gas under a high pressure is a certain evidence of the impermeability of the rocks in which this coal has been shut up.

On Methyl-iodoform. — Pierre de Boissieu.— This compound melts with decomposition at 95°. It is very soluble in carbon disulphide, benzol, and ether, less so in petroleum ether, sparingly soluble in alcohol if cold, but more so if hot

Action of Crystalline Formic Acid upon Citrene.—J. Lafont.—The author obtains, among other products, a carbide, $C_{40}H_{32}$, probably analogous to that described by Deville and Reban, but which he names diterpilene.

The Sugars of Hesperidine and Isohesperidine.—C. Tanret.—The author has studied the saccharine matters produced when hesperidine and isohesperidine are split up under the action of dilute acids. The sugar derived from both these compounds is a mixture of glucose and of isodulcite.

Preparation of Isopropyl-acetylene with Methyl-isopropyl-carbonyl.—A. Béhal.—The removal of hydrogen from bi-halogenised carbides cannot be effected in the same manner as in the mono-substituted derivatives of the saturated carbons.

Application of Senarmont's Process to the Reproduction of Celestine and Anglesite in the Moist Way.—L. Bourgeois.—To obtain crystals of celestine the author dissolves strontium sulphate in an excess of hydrochloric acid in 2 vols. of water and heats the whole in a sealed tube to 150°. Anglesite in crystals may be produced in an analogous manner, using lead sulphate. The same method may be applied to the crystallition of lead chromate (crocoisite), using nitric instead of hydrochloric acid.

Influence of Certain so-called "Negative" Radicles upon the Functions of Certain Groupings.—Alb. Haller.—This memoir does not admit of useful abridgment.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Preservation of Milk.—Can any reader inform me of a good preservative for milk? I know salicylic acid is sometimes used, but as this gives a slight flavour it will be useless for my purpose. I believe there must be something better. I should also like to know the length of time it would act.—H. E. S. H.

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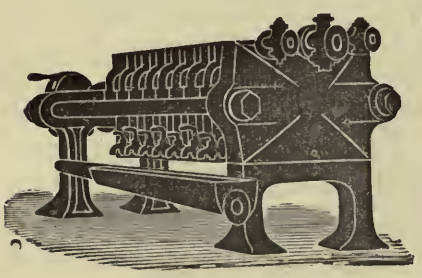

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INDEX.

ABERCROMBY, R., height, length, and velocity of ocean waves, 90
Aberystwith, University College, 24
"Accumulators, Management of, and Private Light Installations" (review), 100
Acetic acid, detection of, 83
Acetone, action of, 117
Acetanilide, action of phosphorus pentachloride on, 255
Acetylene, ethyl-propyl, 121
Acid, acetic, action of glacial, 171
detection of, 83
amido-butyric, formation of, 262
arsenic, action of sulphuretted hydrogen on, 54
boracic, 162
boric, estimation of, 158
carbolic, proportion of phenol in crude, 92
formic, action on French oil of turpentine, 51
hydrochloric, action of, 70, 220
hydrocyanic, detection of, 231
hydrous oxalic, dissociation of, 106
molybdic, novel hydrate of, 121
nitric, action of some micro-organisms on, 89
in well waters, detection of, 212
nitrous, determining, 89
oxalic, action on cinchonine, 51
oxidation of, 168
oxygen, of sulphur, 150
phenyl-isobutyric, derivatives of, 168
phosphites of the alkaline metals, 211
phosphoric, and moisture, methods for determining, 17
determination of, 211, 222
determination of soluble, 15
in vegetation, 140
soluble, of superphosphates, 63
picric, various modes of the explosive decomposition of, 23
pyrogallic, detection of, 222
resisting cement, 62
saccharic and mucic, derivatives of, 161
salicylic, detection of, 222
colorimetric determination of, 262
speed of transformation of meta-phosphoric, 51
of reactions of Iceland spar with, 263
tartaric, determination of, 250
uric, determination of, 243
vanadic, action of, 70
Acidity of carbonic acid, 214, 241
Acids and anhydrides, action of on terpilenols, 181
chromorganic, 108
citric, tartaric, and malic, distinction, 230
isomeric, combustion heats of, 202
sulphuric and phosphoric, estimation of, 165, 187
Aconitum napellus, alkaloids of, 251
Agar-agar, sugar from, 82
"Agricultural Society of England, Journal" (review), 230
"Albumen in Urine, Various Modes for Testing" (review), 68
Albumenoids in wheat grains, detection of, 71
"Alcohol, Treatise on" (review), 179
Alcohol in water, 232, 242
trichloric, 171
Alcoholic fermentation, bases from liquids which have undergone, 80
fermentation of sugar, glycol in the products of, 62
Alcohols, action of, 90
detection of impurities in, 202
impurities in industrial, 170
study of, 171
Aldehyd, glyceric fermentable, 23
ammonias, action of triocyanates on, 116
Aldehyds, combination of glycol with certain, 141
detection of, 13
Alexander, J., and T. Carnelley, colour of some carbon compounds, 217
Alkalies and alkaline earths, separation of uranium from, 221
indirect determination of, 212
Alkaline phosphates, action of, 250
Alkaloids, attempt at a diagnosis of the volatile, 2, 23
of Aconitum napellus, 251
volumetric determination of, 231
Allen, A. H., precipitation of hop bitter by lead acetate, 53
use of the word "assay," 140, 170
Allen, A. J., solubility of calcium compounds, 236
Allihn, F., burette stand with spiral spring clip, 70
Alloisomerism, 184, 195, 205, 215, 224
Alum-stone and sulphur in New South Wales, 64
Alumina and iron oxide, separation of, 221
Aluminium chloride, new reaction of, 142
in iron, 249, 261
iron, nickel, cobalt, manganese, and zinc, separation of, 125
methyl, vapour density of, 121
Amagat, E. H., expansion of compressed liquids, 12
Amat, L., acid phosphites of the alkaline metals, 211
existence of pyro-phosphorous acid, 220
"American Pharmaceutical Association" (review), 169
Amido-butyric acid, formation of, 262
Ammonia compounds with selenium dioxide, 163
determination of, 81
in arable soils, determination of, 242
Amphlett, E. G., and H. E. Armstrong, isomeric change in the naphthalene series, 8
Analyses of dairy products, 83
of graphite, 36
Analysis and composition of antimonium potassium oxalate, 193, 241
elementary, lead chromate in, 221
of a mixture, 152
of bad water, 171
of cattle foods, 77
of milk, 98
of mixed paints, 11, 31
of nickel, 251
of the nitrites, 33
quantitative, of the constituents of milk, 81
"Analysis, Introductory Inorganic" (review), 261
"Analysis for Students, Quantitative" (review), 23
"Analysis, Organic" (review), 179
"Analysis, Qualitative" (review), 179
Analyst, public, for Islington, 164
André, G., action of certain oxides, 150
and M. Berthelot, absorption of saline matters by plants, 150, 161
condition and determination of sulphur and phosphorus in plants, &c., 31
phosphorus and phosphoric acid in vegetation, 140
Anglesite and celestine, reproduction of, 263
Anhydride, formic action of, 171
molecular weights of nitric peroxide and nitrous, 197
Anhydrides of mannite, 220
Aniline colours soluble in benzine, 24
formation heat of, 181
Antimonium potassium oxalate, analysis of, 193, 241
Antimony, atomic weight of, 102
Australian gold and native metallic, 64
from tin, separation of, 124
quantitative determination of, 211
Antipyrine and thalline, behaviour of, 102
Apparatus, combustion, 150
new extraction, 235
Appleyard, J. R., and P. Kay, gas liquor, 50
Arable soils, determining carbon in, 102.
Arecan, new volatile alkaloid, 231
Armstrong, H. E., isomeric change in the naphthalene series, 8, 9
H., origin of colour and constitution of colouring matters, 106
Arnaud, M., active crystalline matter of the poisoned arrows of the Somalis, 167
Arnold, C., Kjeldahl's method for the determination of nitrogen 70
J. O., detection of hop substitutes in beer, 33
and H. J. Hardy, influence of phosphorus on the estimation of chromium in iron and steel, 153
Aromatic diamines, characters of some, 171
ketones, 13
Arsenic acid, action of sulphuretted hydrogen on, 54
cyanide of, 245
delicate detection of, 221
detection of, 263
Ash, determination of, 212
"Assay" and "analysis," uses of the terms, 140, 160, 170
"Assaying, Manual of Practical" (review), 240
Atmospheric nitrogen, relations to vegetable mould, 150, 161, 170, 180
Atomic weight, definition of, 218
of antimony, 102
of germanium, 71
weights, logarithmic law of, 163
Atomicity of the inorganic elements, 194

Austen, W. C. R., certain mechanical properties of metals, 133
Australian gold and native metallic antimony, 64
indigenous saline fodder plants, 33
Ayrton, W. E., and J. Perry, governing of electromotora, 228
incandescent lamps, 90
magnetic circuit in dynamo machines, 109
measurement of the coefficient of expansion by heat, 210
Azo-derivatives of benzene, 262
Azo- and diazo-derivatives, constitution of, 217

BACTERIOLOGICAL water-test, 15
Bamberger, E., coloured reaction of the ortho-diketones, 222
Barbier, P., and L. Vignon, new method of forming substituted saffranines, 152, 161
researches on pheno-safranine, 141
Barium, strontium, and calcium, volumetric determination of, 221
"Barley, Wheat, &c., Experiments on the Growth" (review), 129
Barlow, J. J., improved modification of Soxblet's apparatus, 56
Bases, volatile, in blood, 62
Batteries, E.P.S., storage for telegraphic purposes, 51
Baubigny, H., sulphuretted hydrogen for purifying cobalt and nickel salts, 55
Bauer, R. W., sugar obtained from agar-sgar, 82
O., and A. Classen, application of hydrogen peroxide in analytical chemistry, 70
Baumann, A., determination of ammonia, 81
Beckurts, H., proportion of phenol in crude carbolic acid, 92
Beer, detection of hop substitutes in, 33, 61
manufacture and adulteration of, 23
Béhal, A., caprylidene of caprylene, 161
ethyl-propyl-acetylene, 121
Bell scholarship, 13, 24
Bellamy, F., production of chlorine, 41
Benoist, L., and C. Collin, estimation of tannin, 214
Benzene, azo-derivatives of, 262
Benzine, aniline colours soluble in, 24
Benzyl-dithio-urethane, 108
Bernheim, J., and G. Rousseau, production of crystalline ferric hydrates, 241
Berthelot, M., ancient process for rendering jewels and vitrifications phosphorescent, 101
fixation of nitrogen by vegetable mould, 121, 180, 191
transformation of nitrates into nitrogenous organic compounds in the soil, 131
various modes of the explosive decomposition of picric acid and of nitro-compounds, 23
and G. André, absorption of saline matters by plants, 150, 161
condition and determination of sulphur and phosphorus in plants, &c., 31
phosphorus and phosphoric acid in vegetation, 140
Bevan, E. J., and C. F. Cross, "Paper Making" (review), 21
and C. M. King, E. Joynson, G. Watt, and C. F. Cross, "Report on Indian Fibres and Fibrous Substances" (review), 129
Beyer, A., soluble phosphoric acid of superphosphates, 63
Bibasic glycerinates, preparation of, 131
Binder, O., detection of nitric acid in well waters, 212
Bird-lime, composition of, 60
Bischof, G., bacteriological water-test, 15
Bismuth, effect of magnetisation on the thermo-electrical properties of, 49
in silver, effect of, 191, 192
Blake, J., atomicity of the inorganic elements, 194
Blakesley, T. H., magnetic lag, 209
Blood, detection of carbon monoxide in, 231
volatile bases in, 62
Blount, B., determination of carbon in steel, 27
Bloxam, C. L., "Chemistry, Inorganic and Organic" (review), 30
Blumenbach, E., behaviour of thalline and anti-pyrine, 102
Blyth, A. W., "Foods: their Composition and Analysis" (review), 10
Blythe, G. W., cyanide of arsenic, 245
Boilers, incrustation in, 121
Bolton, H. C., rock-salt mines of Petite Anse, 234
Bombelon, E., new volatile alkaloid, arecan, 231
Bone-black, determination of the decolourising power of, 101
Bonn University, Chemical Institute of, 12
Boracic acid, 162
Borchers, W., determination of carbonic acid in neutral mineral waters, 250
Boric acid, estimation of, 158
Bosanquet, R. H. M., use of the term "resistance," 68
Bostock, G. H., improved chemical apparatus, 213, 249
Bottone, S. M, "Electrical Instrument Making for Amateurs" (review), 139
Bouchardat, G., and R. Voiry, essence of spike lavender, 111
terpinol, 211, 131
Boulzoureano, M., certain selenites, 121
Bourgeois, L., artificial reproduction of hydrocerussite, 262
reproduction of celestine and anglesite, 263
Bouty, E., electric conductivity of concentrated nitric acid, 131
Bowen, H. C. and E. Waller, determination of nitrogen, 236
Boys, C. V., experiments with soap bubbles, 160, 200, 238
radio-micrometer, 200
and A. W. Rücker, optical demonstration of electrical stress, 50, 199
Braithwaite, J., "Retrospect of Medicine" (review), 40
Bramwell, F., gradational colour blender, 238
Brand, A., use of solidified bromine, 62
Brannt, W. T., "Animal and Vegetable Oils and Fats" (review), 149
Brauner, B., densities of cerium sulphate solutions, 90
Brazing and welding, new departure in, 40
Breweries, bacteria in, 23
Bricks, colour of, 80
Bromide, iodide, and cuprous chloride with aniline compounds, 219
chloride, and iodide of cadmium, action of calcium carbonate on, 258
Bromine, action of, 160
chlorine, &c., indirect determination of, 251
detection of, 251
determination of, 233, 245
pipette for measuring, 250
Bromine, use of solidified, 62
Bromobenzenes, 121
Brown, H. T., and G. H. Morris, molecular weights of the carbohydrates, 196
Brulle, R., sophistications of olive oils, 170
Büchner, G., cadmium sulphide, 150
detection of arsenic, 263
Bujwid, O., chemical reaction for cholera bacteria, 231
Bumping ebullition, 244
Bunsen, R., steam calorimeter, 250
Burette stand with spiral spring clip, 70
Burus, W., "Manufacture of Gas" (review), 10
Burton, C. V., electromotive force by contact, 178
W. M., and H. N. Morse, estimation of boric acid, 158
supposed dissociation of zinc oxide, 175
Butter, analyses of, 83
and milk, determination of total solids and fat, 242
examination of, 92

CADMIUM sulphide, 150
Cailletet, L., and E. Colardeau, refrigerating mixtures, 262
Cajeput, oil of, 241
Calcium and zinc, alloys of, 143
carbonate, action on cadmium chloride, bromide, and iodide, 258
compounds, solubility of, 236
Calmels, G., and E. Hardy, synthesis of pilocarpine, 132
Cameron, C. A., and J. Macallan, compounds of ammonia with selenium dioxide, 163
J., "Soaps and Candles" (review), 261
Canada, Royal Society, 259
Caoutchouc, optical and chemical properties of, 247
Capacities, method of comparing very unequal, 248
Caprylidene of caprylene, 161
Carbide of iron, magnetic, 42
Carbohydrate, novel, 111
Carbohydrates, molecular weights of the, 196
Carbolic acid, proportion of phenol in crude, 92
Carbon at high temperatures, experiments on, 253
compounds, colour of some, 217
volatility of the poly-oxygenated, 181
funnels for filtering, 223
in arable soils, determining, 102
in steel, determination of, 27
monoxide in blood, detection of, 231
tetrachloride, action of, 180
Carbonic acid, acidity of, 214, 241
in neutral mineral waters, determination of, 250
in solution, determining, 12
Carnegie, D. J., titration of ferric salts, 148
and S. Ruhemann, action of acetone, 117
Carnelley, T., and J. Alexander, colour of some carbon compounds, 217
and J. Dunn, action of hot copper, 163
Cassino, S. E., "International Scientists' Directory" (review), 219
Cast-irons, 181
Caventon, N., and M. Girard, action of oxalic acid on cinchonine, 51
Cazeneuve, P., and M. Hugounenq, pterocarpine and homopterocarpine, 111
Celestine and anglesite, reproduction of, 263
Cerium sulphate solutions, densities of 90
Chautard, P., cyan-aldehyd, 181
Cheadle Railway, Mineral, and Land Company, 32
Chemical action of some micro-organisms, 246
and optical properties of caoutchouc, 247
apparatus, improved, 213, 249
designations, 142
Institute of the University o Bonn, 12
investigation of Wackenroder's solution, 87
laboratory at Wiesbaden, 112
literature, 142
manufacturers of America, 222
nomenclature, fantastic, 141
patents taken out in Berlin, 192
Society, 8, 48, 58, 87, 106, 115, 147, 167, 196, 206, 216, 226, 246
structure of the natural silicates, 176, 188
"Chemical Analysis by Electrolysis, Quantitative" (review), 68
Chemistry, Institute of, 50, 61, 79, 91, 100, 110, 117, 120, 126, 152
of the onion as a field crop in Australia, 95
application of hydrogen per oxide in, 70
as known to the ancients, history of, 232, 242
"Chemistry, Elementary" (review), 169
"Chemistry, Fundamental Principles of" (review), 149
"Chemistry, Handbook of Modern" (review), 219
"Chemistry, Inorganic, Notes on" (review), 240
"Chemistry, Modern Theories of" (review), 119
"Chemistry, Organic and Inorganic" (review), 30
"Chemistry, Short Text-Book of Inorganic" (review), 249
"Chemistry, Students' Handbook" (review), 11
"Chemistry, Inorganic Text-book of" (review), 139
"Chemistry, Treatise on" (review), 68
"Chemistry, Watts's Dictionary of" (review), 169
Chemists, warning to, 23, 30
Chevreul, E., part played by nitrogen in vegetable economy 230
Chinese dyed silks, 203
Chloride, hydrated methyl, 211
of sulphur, action of on oils, 26 43, 113
of zinc, 232
Chlorides and sulphates in aqueous solution, Is there a constant relation between the heats of formation? 36
experiments on metallic, 16
Chlorine, bromine, &c., indirect determination, 251
derivatives, preparation of some novel, 151
effect of on the electromotive force of a voltaic couple, 184
gas, generating, 82
&c., Potilitzin's law of mutua displacement, 88
production, 41
Chloro-derivatives of acetic ether 161
Chloroform, impurity in, 102
splitting up of, 101
Cholera bacteria, chemical reaction for, 231
Chrome and manganese in their fluorescent compounds. At what degree of oxidation? 32
iron ore in Australasia, 1
Chromium, estimation in iron or steel, 153
Chromorganic acids, researches on, 108
Chronometer for moderately deep tints, 77
Church, A. H., "Colour: Elementary Manual for Students" (review), 21

Cinchonibine, 220
Cinchonigine, 80
Cinchoniline, 131
Cinchonine, action of oxalic acid on, 51
optical isomerisms of, 32
Citrene, action of formic acid on, 263
Citric acid and tartaric and malic acid, distinction between, 230
City and Guilds of London Institute, 196
Clarke, F. W., chemical structure of the natural silicates, 176, 188
Classen, A., and O. Bauer, application of hydrogen peroxide in analytical chemistry, 70
and W. H. Herrick, "Quantitative Chemical Analysis by Electrolysis" (review), 68
Coal formation, study of, 263
Cobalt and nickel salts, sulphuretted hydrogen for purifying, 55
manganese, zinc, aluminium, iron, and nickel, separation of, 125
Codeine, detection of, 102
Colardeau, E., and L. Cailletet, refrigerating mixtures, 262
Collie, N., and A. T. Lawson, action of heat on the salts of tetra-methyl ammonium, 198
Collin, C., and L. Benoist, estimation of tannin, 214
Collins, W. H., analyses of graphite, 36
"Colour" (review), 21
blender, gradational, 238
origin of, 106
Colouring-matters, Berlin patents, 41
constitution of, 106
of decaying wood, 122
Combes, A., new reaction of aluminium chloride, 142
two isomeric naphtho-quinolines, 241
Conessine and wrightine, 251
Cook, E. H., "Introductory Inorganic Analysis" (review), 261
Copper antimonide in Nature, 138
hot, action of, 168
metallic, action of sulphur vapour on, 95
electro-crystallisation of, 184
ores, rich, determination of, 201
"Copper Smelting, Modern American Methods" (review), 22
sulphide, colloidal, 111
Coram, H. C., apparatus for generating gases, 241
Cotton fibre, detection of, 192
oil in olive oil, detection of, 111, 211
Couldridge, W., nitrogen chlorophosphuret, 90
Coulomb meter, 200
Coulson, A., characters of the secondary aromatic diamines, 171
Cowan, G. C., and J. A. Ewing, magnetic qualities of nickel, 203
Crookes, W., Address to Chemical Society, 198, 206, 216, 226
and J. Mitchell, "Manual of Practical Assaying" (review), 240
W. Odling, and C. M. Tidy, London water supply, 39, 67, 125, 166, 204, 245
Cross, C. F., and E. J. Bevan, "Paper-making" (review), 21
C. M. King. E. Joynson, and G. Watt, "Report on Indian Fibres and Fibrous Substances" (review), 129
Cundall, J. T., and W. A. Shenstone, hydrated calcium sulphate, 167
Curtmann, O., detection of salicylic acid, 222
Cyanaldehyd, 181
Cyanide of arsenic, 245
"Cyclopædia, Everybody's" (review), 139

DAIRY products, analyses of, 83
Dale, S. P., limit of refraction, 67
Dalton, W. H., and W. Whittaker, "Geological Record" (review), 169
Day, T. C., estimating nitrites, 117
De Boeck, G., and W. Spring, colloidal copper sulphide, 111
De Boisbaudran, M. L., at what degree of oxidation are chrome and manganese in their fluorescent compounds? 32
fluorescence of cupriferous lime, 220
De Boissieu, P., methyl iodoform, 263
Debray, H., and A. Joly, researches on ruthenium, 51, 80, 241
preparation of potassium fluoride, &c., 111
Debus, M., chemical investigation of Wackenroder's solution, 87
De Coninck, M. O., attempt at a diagnosis of the volatile alkaloids, 2, 23
study of the ptomaines, 150, 250
De Forcrand, M., preparation of bibasic glycerinates, 131
and M. Villard, formation of the hydrates of gases, 161
hydrated methyl chloride, 211
De Mondesir, P., absorbent power of soils, 101
De Schulten, A., action of calcium carbonate on cadmium chloride, bromide, and iodide, 258
De St. Martin, L., splitting up of chloroform, 101
Déhérain, P. P., manufacture of farmyard manure, 170
Dehydromorphene, 262
Delachanal, M., and M. C. Vincent, novel carbohydrate, 111
Delacre, M., chloro-derivatives of acetic ether, 161
trichloric alcohol, 171
Demarcay, E., spectral rays of gold, 191
Deslandres, H., determination of two red rays of potassium, 141
Dewar, J., and G. D. Liveing, spectrum of the oxy-hydrogen flame, 53
Diamines, aromatic, characters of some, 171
Dihydrazides of diketones, formation of, 60
Diketones, new method of obtaining monohydrazides of, 59, 60
Ditte, A., action of vanadic acid, 70
Divers, E., and M. Kawakita, composition of bird-lime, 60
Dixon, A. E., action of triocyanates on aldehyde ammonias, 116
benzyl-dithio-urethane, 108
Donath, E., and R. Jeller, determination of rich copper ores, 102
Dragendorff, M., detection of phenol, 102
Draper, H. N., acidity of carbonic acid, 241
Drouin, R., and A. Gautier, fixation of nitrogen by the soil and by plants, 150, 161, 181, 191, 250
Drown, T. M., funnel for filtering carbon, 223
Duet, H., reproduction of pharmakolite, 187
Dunn, J., and M. Carnelley, action of hot copper, 168
Durham, W., solution, 179, 249
Dutrochet, endosmose of, 141
Dynamo machine, condition of self-excitation, 209
Dynamo machines, magnetic circuit in, 109

EARRINGS, leaden, 32, 132, 172
East, F. J., and R. Meldola, compounds of the naphthaline series, 148
Ebs, K., aromatic ketones, 13
Edeleanu, L., derivatives of phenyl-isobutyric acid, 168
"Education, Practical" (review), 128
Electric lamps, exhibit, 201
conductivity of concentrated nitric acid, 131
Electrical influence machine, large, 199, 238
"Electrical Instrument Making for Amateurs" (review), 139
stress, optical demonstration of, 50, 199
"Electricity and Magnetism, Treatise on" (review), 178
Electro-crystallisation of metallic copper, 184
Electrolysis and electrification, 143
experiments, 91, 229
"Electrolysis, Quantitative, Chemical Analysis by" (review), 68
Electromotive force by contact, 178
Electromotors, governing, 228
Elements and meta-elements, 206, 216, 226
Elements, new, 170, 180
Emmerling, A., determination of soluble phosphoric acid, 15
Endosmose of Dutrochet, &c., 141
Engel, E., action of hydrochloric acid, 70, 220
M., formation of amido-buyric acid, 262
R., constitution of inosite, 111
Eolipyle, new, 140
E. P. S. storage batteries, for telegraphic purposes, use of, 51
Epsomite in New Zealand, 114
Equivalents, determining, method of, 166
Etard, A., decreasing solubility of sulphates, 62, 141
Ether, acetic, some chloro-derivatives of, 161
propio-propionic, constitution of, 12
Ethylamine, compressibility of the watery solution of, 13
Ethyl disulphide, Guthrie's chlorised, constitution of, 152
Eucalyptus globulus, oil of, 220
Ewing, J. A., and G. C. Cowan, magnetic qualities of nickel, 203
Explosives Act, 1875, 41
"Explosives, Literature of" (review), 30
"Explosives, Twelfth Annual Report of Her Majesty's Inspectors" (review), 260

FABRE, C., specific heat of tellurium, 32
Farmyard manure, manufacture of, 170
Farrington, T., acidity of carbonic acid, 214
how is it done? 160
Fat extraction apparatus, 130
Fay, J. W., is there a constant relation between the heats of formation of chlorides and sulphates in aqueous solution? 36
Ferric hydrates, 181, 241
salts, titration of, 148
Fibres, distinction between vegetable and mineral, 71
"Fibres, Indian, Report on" (review), 129
method of distinguishing animal from vegetable, 12
Filter cutting apparatus, 221
Finkener, M., detection of mineral oils in pine oils, 231
Fischer, H., bacteria in breweries, 23
Fison, A. H., method of comparing very unequal capacities, 248
Fleck, M., examination of mealy substances, 91
Fletcher, T., new departure in brazing and welding, 40
Fluids, evaporating, 250
Fluorine, apparatus for the isolation of the element, 200
"Foods" (review), 10
cattle, method for the analysis of, 77
Forbes, G., coulomb meter, 200
Formic acid, action upon citrene, 263
on French oil of turpentine, action of, 51
Fox, W., analysis of mixed paints, 11, 31
Franceines, 70
Frankland, P. F., action of some specific micro-organisms on nitric acid, 89
gasometric method of determining nitrous acid, 89
Fream, W., "Rothamstead Experiments on Wheat, Barley, &c." (review), 129
Fremy, E., and A. Verneuil, artificial production of rhombohedric crystals of rubies, 121
French technical terms, 262
Fresenius, R., generating pure sulphuretted hydrogen, 81
Friswell, R. J., Institute of Chemistry, 80, 100, 120
Fulminates, recent investigations on, 255
Furfurol, colour bases from, 12
Furneaux, W. S., "Elementary Chemistry" (review), 169
Fusel oil, determination of, 91

GALLOWAY, R., "Fundamental Principles of Chemistry" (review), 149
Galvanometer, modified, Maxwell's, 239
Gantter, F., analysis of milk and butter, 242
determination of tannin, 242
tartaric acid, 250
Gas and solutions, analogy between, 248
chlorine, generating, 82
liquor, 50
market value of, 171
pipette, new, 251
"Gas Manufacture" (review), 10
Gases, evolution of, 233
hydrates of formation of, 161 202
simple form of apparatus for generation, 213, 241, 249
Gautier, A., and R. Drouin, fixation of nitrogen by the soil and plants, 150, 161, 181, 191, 250
Gawalowski, A., determination of mineral oils, 81
Gayon, U., detection of aldehyds in the alcohols of commerce, 13
Gee, W. W. H., and H. Holden, experiments on electrolysis, 229
and C. H. Lees, electrolysis experiments, 91
Genther, A., constitution of propio-propionic ether, 12
Germanium, atomic weight of, 71
Gernez, D., application of rotatory power, 241
"Geological Record" (review), 169
Gilpin, E., jun., notes on Nova Scotia gold mines, 260
Girard, M., and M. Caventon, action of oxalic acid on cinchonine, 51
Glacial acetic acid, action of, 171

Gladstone, J. H., and W. Hibbert, optical and chemical properties of caoutchouc, 247
Glucose detection, 251
Glue, 13
Glyceric aldehyd, fermentable, 23
Glycerinates, bibasic, preparation of, 131
Glycol, combination with certain aldehyds, 141
in the products of the alcoholic fermentation of sugar, 62
Godefroy, L., detection of impurities in industrial alcohols, 170
Gold, Australian, and native metallic antimony, 64
certain spectral rays of, 191
ear-wires, Goldsmith's Hallmark on, 172
healing properties of, 72
in tin, 142
mines of Nova Scotia, 260
mining, Welsh, 252
Welsh, 239
Gore, G., effect of chlorine on the electromotive force of a voltaic couple, 184
minimum point of change of potential of a voltaic couple, 254
Gorgen, A., action of roasting on several oxides of manganese, 141
Gossage, A. M., volumetric determination of uric acid, 243
Göttig, M., filter-cutting apparatus, 221
Graphite, analyses of, 36
Greville, H. L., "Student's Handbook of Chemistry" (review), 11
Grimaux, E., fermentable glyceric aldehyd, 23
Guiacum resin, distinction between purified and natural, 71
Gunning, J. W., evaporating fluids, 250
Gustavson, G., determining carbon in arable soils, 102
Guthrie's ethyl disulphide, constitution of, 152

HAEUSSERMANN, C., determination of small quantities of paratoluidine, 262
Hager, H., detection of codeine, 102
distinction between purified and natural guiacum resin, 71
Hambly, F. J., and T. E. Thorpe, manganese trioxide, 48
Hampe, W., opening up tin ore, 221
Hardy, E., and G. Calmels, synthesis of pilocarpine, 132
Hardy, H. J., and J. O. Arnold, influence of phosphorus on the estimation of chromium in iron or steel, 153
Hartley, W. N., definition of the term atomic weight, 218
"Quantitative Analysis for Students" (review), 20
Hautefeuille, P., and J. Margottet, ferric phosphates and alumina phosphates, 51
and A. Perrey, mineralising action of alkaline sulphides, 101
Heat, action of on the salts of tetramethyl-ammonium, 198
measurement of the coefficient of expansion by, 210
specific, of tellurium, 32
Henninger, M., and M. Sanson, glycol in the products of the alcoholic fermentation of sugar, 62
Henry, L., volatility of the polyoxygenated carbon compounds, 181
Heppe, G., detection of spermaceti in oil of roses, 263
Hereth, F. S., volumetric determination of alkaloids, 231
Hibbert, W., and J. H Gladstone, optical and chemical properties of caoutchouc, 247
Hoff, V., analogy between dilute solutions and gases, 248
Hoffmann testimonial fund, 132, 231
Hodgkinson, W. N., and F. K. Lowndes, new lecture apparatus for making sulphuric anhydride, 193
Holden, H., and W. W. H. Gee, experiments on electrolysis, 229
and C. H. Lees, experiments on electrolysis, 91
Holland, P., examination of quartz conglomerate, 76
Homogeneous liquids, evolution of gases from, 233
Homopterocarpine, 111
Hop bitter, precipitation of by lead acetate, 53
substitutes in beer, detection of, 33, 61
How is it done? 160
Hugounenq, M., preservation of wines, 111
and P. Cazeneuve, pterocarpine and homopterocarpine, 111
and M. Maret, sodium-potassium carbonate, 181
Huntly, G. N., and F. R. Japp, action of phenyl hydrazides on unsaturated diketones, 60
Hunt, T. S., classification and nomenclature of metalline species, 259
Hydrates, 171
crystalline ferric, 241
ferric, 181
metallic, action of Rochelle salt on, 223
of gases, formation of, 161, 202
certain novel, 249
Hydrazo-camphenes, oxidation products of, 131, 141
Hydrocarbons accompanying diterebenthyl in resin oils, 180
Hydrocerussite, artificial reproduction of, 263
Hydrochloric acid, action of, 70, 220
Hydrocyanic acid, detection of, 231
Hydrogen and oxygen, relative densities of, 73
sulphuretted, absorption of small amounts of, 142
for purifying cobalt and nickel salts, 55
solution, preservation of, 173
sulphuric, action on arsenic acid, 54
Hydroxyl group, reagent for, 222
Hyposulphurous acid in urine, detection of, 71

ICELAND spar, speed of reaction with acids, 263
Iles, M. W., lead slags, 4, 18, 37, 43, 57
Inactose of neutral sugar, 170
Indigo-dyes, testing, 171
Indigoes, valuation of, 7, 19, 29, 34
Induction, variation of the coefficients of, 159
Industrial reviews and patents, 151
Ink, printing, to remove stains, 13
stains, 52
"Inorganic Analysis, Introductory" (review), 261
"Inorganic Chemistry, Textbook of" (review), 139
"Inorganic Chemistry, Short Text-book of" (review), 249
Inorganic elements, atomicity of, 194
"Inorganic Evolution" (review), 190
Inosite, constitution of, 111
Institute of Chemistry, 50, 61, 79, 91, 100, 110, 117, 120, 126, 152
Institution, Royal, 128, 132, 139, 180, 189, 210, 229
Iodide of starch, 183
Iodine, estimation of, 45, 135
titration of solutions of, 251
Iodoform, methyl, 263
Iodometric studies, 62
Iron, aluminium in, 249, 261
and nickel, passive state of, 180
sudden loss of magnetic properties of, 178
estimation of chromium in, 153
in slags, metallic, 171
magnetic, carbide of, 42
nickel, cobalt, zinc, manganese, and aluminium, separation of, 125
ore, chrome, in Australasia, 1
oxide and alumina, separation of, 221
Irving, A., colouring-matters of decaying wood, 122
Isambert, F., compressibility of the watery solution of ethylamine, 13
Isbert, A., and A. Stutzer, determination of phosphoric acid, 211
Isodulcite, 149
Isomeric acids, combustion heats of, 202
Istrati, M., franceines, 70

JACOBS, M. A., aniline colours soluble in benzene, 24
Jacquemin, G., Saccharomyces ellipsoideus, 131
Jansen, J., spectra of oxygen, 181
Japp, F. R., and F. Klingemann, new method of obtaining monohydrazides of diketones, 59, 60
Jeller, R., and E. Donath, determination of rich copper ores, 102
Jewels, phosphorescent, ancient process for rendering, 101
Johnson, G. S., detection of acetic acid in presence of morphine, 83
simple form of apparatus for generating gases, 213, 241
Matthey, and Co., new gas burner, 200
Johnson, G., "Various Modes for Testing for Albumen in Urine" (review), 68
Johnstone, W., detection of hop substitutes in beer, 61
Joly, A., and H. Debray, researches on ruthenium, 51, 80, 241
Jürgens, A., alkaloids of Aconitum napellus, 251
Joubert, J., and E. Mascart, "Treatise on Electricity and Magnetism" (review), 178
Joynson, E., "Report on Indian Fibres" (review), 129
Jungfleisch, E., and E. Léger, cinchonibine, 220
cinchonigine, 80
cinchoniline, 131
optical isomerisms of cinchonine, 32

KALMANN, W., titration of solutions of iodine, 251
Kawakita, M., and E. Divers, composition of bird-lime, 60
Kay, P., analysis and composition of antimonium potassium oxalate, 193
and J. R. Appleyard, gas liquor, 50
Kestner, S, use of Thompson's calorimeter to determine the heating power of coal, 161
Keyworth, G. A., to remove stains of printing ink, 13
King, C. M., new extraction apparatus, 235
"Report on Indian Fibres" (review), 129
Kingzett, C. T., "Nature's Hygiene" (review), 229
Kjeldahl's method for the determination of nitrogen, 65, 70, 211, 231, 236
Kliebahn, G., detection of pyrogallic acid, 222
Klingemann, F., and F. R. Japp, new method of obtaining monohydrazides of diketones, 59, 60
Klobb, T., nnvel permanganates, 132
Knecht, E., constitution of ammonium potassium oxalate, 241
modification of Soxhlet's apparatus, 91
Knöfler, O., volumetric determination of barium, strontium, and calcium, 221
Kohnstein, B., presence of soluble "weighting" ingredients in leather, 101
Koch, Dr., bacteriological water-test, 15
Kolbe, H., "Short Text-book of Inorganic Chemistry" (review), 249
Krause, M., fantastic chemical nomenclature, 141
Kraut, K., indirect determination of alkalies, 212

LAFONT, J., action of acids and anhydrides on terpilenols, 181
of crystalline formic acid upon citrene, 263
of formic acid on French oil of turpentine, 51
of glacial acetic acid, 171
Laist, A., and T. H. Norton, copper antimonide in Nature, 138
Lamont-Frolich formula for induced magnetism, 178
Lamps, incandescent, 90
Landwehr, H. A., reagent for the hydroxyl group, 222
Langbein, G., analysis of nickel, 251
Lanoline, 181
Lantern, new form of, 248
Laube, G., determination of the decolourising power of bone-black, 101
Lavender, spike, essence of, 111
Lawson, A. T., and N. Collie, action of heat on the salts of tetramethyl ammonium, 198
Le Chatelier, H., oxidation of silver, 142
Lead acetate, precipitation of hop-bitter by, 53
chromate in elementary analysis, 221
slags, 4, 18, 37, 43, 57
Leather, presence of soluble "weighting" ingredients in, 101
Lecrenier, A., and W. Spring, constitution of Guthrie's chlorised ethyl disulphide, 152
preparation of some novel chlorine derivatives, 151
Lees, C. H., W. W. H. Gee, and H. Holden, experiments on electrolysis, 91
Léger, E., and E. Jungfleisch, cinchonibine, 220
cinchonigine, 80
cinchoniline, 131
optical isomerisms of cinchonine, 32
Leide, E., rhodium sesquisulphide, 241
Leighton, G. W., analysis of a crystalline scale, 3
Leland, C. G., "Practical Education" (review), 128
Lenz, L., determination of nitrogen, 211
W., testing indigo dyes, 171
Leplay, H., endosmose of Dutrochet, &c., 141
Leroy, A. J., bromo-benzenes, 121
Lescœur, H., dissociation of hydrous oxalic acid, 106
Levulose, 191
Levy, L., an alloy of titanium and aluminium with silicon, 51
Liebreich, O., biological function of lanoline, 181

"Light Installations, Management of Accumulators and Private" (review), 100
Light, polarised, action of oils with, 142
Lightning-rods, price of the factor of safety in, 50
Limb, C., and E. J. Maumené, hydrates, 171
Lime, cupriferous, fluorescence of, 220
Lindo, D., preservation of sulphuretted hydrogen solution, 173
Lindt, O., micro-chemical detection of phloroglucine, 71
Liquids, compressed, expansion of, 12
measuring by drops, 39
method of finding the specific gravity of, 138
Liveing, G. D., and J. Dewar, spectrum of the oxyhydrogen flame, 53
Ljubavin, M., lead chromate in elementary analysis, 221
Lochert, H., action of bromine, 160
combination of glycol with certain aldehyds, 141
Lockyer, J. N., experiments illustrating low temperature spectra, 200, 239
Logarithmic law of atomic weights, 163
"London, Port of, Report of the Medical Officer of Health for" (review), 190
London water supply, 39, 67, 125, 166, 204, 245
Long, J. H., oxidation of sewage, 256
Louguinine, W., combustion heats of the isomeric acids, 202
Louise, E., and L. Roux, vapour density of aluminium-methyl, 121
Lovett, W. J., Institute of Chemistry, 91
Lowndes, F. K., and W. R. Hodgkinson, new lecture apparatus for making sulphuric anhydride, 193
Ludié, E., rhodium sesquichloride, 180
Lumsden, A. A., fat extraction apparatus, 130
Lunge, G., theory of the vitriol chamber process, 49, 69
Lunge's improved nitrometer 203

MACALLAN, J., and C. A. Cameron, compounds of ammonia with selenium dioxide, 163
Macgregor, J. G., table of the cubical expansion of solids, 259
MacIvor, R. W. E., alum stone and sulphur in New South Wales, 64
Australian gold and native metallic antimony, 64
indigenous saline fodder plants, 33
chemistry of the onion as a field crop in Australia, 95
chrome iron ore in Australasia, 1
epsomite in New Zealand, 114
exhaustion of virgin soils of Australasia, 25
Magenta, detection of, 165
separation of from the colouring-matter of orchil, 263
Magnetic carbide of iron, 42
lag, 209
"Magnetism and Electricity, Treatise on" (review), 178
Magnetism, influence of, 50
Magnetometer, Kew, note on some additions to, 249
Magnets, formula for the lifting power of, 229
on liquids, method of observing the action of, 71
Manganese, action of roasting on several oxides of, 141
estimation of small quantities of, 48
oxide soluble in water, 112
trioxide, 48
Mannite, anhydrides of, 220
Manufacture of farmyard manure, 170
Maquenne, M., derivatives of saccharic and mucic acid, 161
perseite, 191
Margottet, J., and P. Hautefeuille, ferric and alumina phosphates, 51
Marshall, W., and T. Purdie, action of alcohols, 90
Marx, C., definition of normal solutions for volumetry, 62
Mascart, E., and J. Joubert, "Treatise on Electricity and Magnetism" (review), 178
Maumené, E. J., inactose of neutral sugar, 170
and C. Limb, hydrates, 171
McCay, L. W., action of sulphuretted hydrogen on arsenic acid, 54
McCulloch, N., estimation of iodine, 45
in presence of chlorine and bromine, 135
Mealy substances, examination of, 91
Mean, M., distinction between citric acid and tartaric and malic acids, 230
"Medical Officer of Health for the Port of London, Report" (review), 190
"Medicine, Retrospect of" (review), 40
Meinecke, C., determination of phosphoric acid, 222
Meissl, E., and R. Ullbricht, original standard for volumetry, 81
Meldola, R., and F. J. East, compounds of the naphthaline series, 148
and F. W. Streatfeild, constitution of azo- and diazo-derivatives, 217
Melting-points, determination of, 81
"Merchandise Marks Act, 1887" (review), 230
Metalline species, classification and nomenclature of, 259
Metals, alkaline, acid phosphites of, 211
apparatus for determining the hardness, 200
certain mechanical properties of, 133
separation of, 24
Metaphosphoric acid, speed of transformation, 51
Methyl-iodoform, 263
Meunier, J., anhydrides of mannite, 220
Meyer, L., and C. W. Williams, "Modern Theories of Chemistry" (review), 119
Michael, A., action of phosphorus pentachloride on acetanilide, 255
alloisomerism, 184, 195, 205, 215, 224
behaviour of oxalic ether with resorcine, 13
preliminary notes, 78
Michaelis, H., refrigerator, 221
Micro-chemical detection of phloroglucine, 71
Micro-organisms, chemical action of some, 246
Microtome, selecting, 239
Milk analysis, methods of, 98
and butter, determination of total solids and fat in, 242
preservation of, 263
quantitative analysis of the constituents, 81
Milliau, E., detection of cotton oil in olive oil, 111, 211
process for oil of sesame, 192
Mineral oils, determination of, 81
in pine oils, detection of, 231
Mineral Land, and Railway Co., 32
Mitchell, J., and W. Crookes, "Manual of Practical Assaying" (review), 240
Mixtures, refrigerating, 262
Molecular forces, range of, 58, 96, 105, 114, 123, 136, 144, 155
Molisch, H., distinction between vegetable and mineral fibres, 71
Molybdenum residues, recovery of, 81
Molybdic acid, novel hydrate of, 121
Moore, T., separation of iron, nickel, cobalt, manganese, zinc, and aluminium, 125
Morehead, S. T., method of observing the action of magnets on liquids, 71
Morel, M., and M. Hougounenq, sodium potassium carbonate, 181
Morin, E. C., bases from liquids which have undergone alcoholic fermentation, 80
study of alcohols, 171
Moriodon, 48
Morley, H. F., and M. M. P. Muir, "Watts's Dictionary of Chemistry" (review), 169
Morphia in opium, amount of, 93, 103, 134, 140, 160, 244
Morris, G. H., and H. T. Brown, molecular weights of the carbohydrates, 196
Morse, H. N., and W. N. Burton, estimation of boric acid, 158
supposed dissociation of zinc oxide, 175
Mucic acid and saccharic derivatives, 161
Muck, F., quantitative determination of antimony, 211
Muir, M. M. P., and H. F. Morley, "Watts's Dictionary of Chemistry" (review), 169
Mulhouse Industrial Society, 141, 151, 191, 192
Munk, J., determination of sugar in diabetic urine, 102
Munroe, C. E., "Notes on the Literature of Explosives" (review), 30
Museum, gift of, by Dr. Carnelley to University College, Dundee, 71

NAPHTHALENE series, isomeric change in, 8, 9
Naphthaline series, compounds of the, 148
Naphtho-quinoleines, two isomeric, 241
"Nature's Hygiene" (review), 229
Nef, J. U., carboxy-derivatives of quinone, 117
Nessler, J., dryness of walls, &c., 101
Neumann, G., metallic iron in slags, 171
Newlands, J. A. R., Institute of Chemistry, 80
Nickel, analysis of, 251
and cobalt salts, sulphuretted hydrogen for purifying, 55
and iron, passive state of, 180
sudden loss of magnetic properties of, 178
cobalt, manganese, zinc, aluminium, and iron, separation of, 125
experiments with, 90
magnetic qualities of, 203
Nitrates, transformation into nitrogenous organic compounds in the soil, 131
Nitric acid, action of some micro-organisms on, 89
electric conductivity of concentrated, 131
in well-waters, detection of, 212
peroxide and nitrous anhydride, molecular weights of, 197
Nitrites, analysis of, 33
estimating, 117
Nitro-compounds, various modes of the explosive decomposition of, 23
Nitrogen, atmospheric, relations to vegetable mould, 150, 161, 170, 180
chlorophosphuret, 90
fixation of, 121, 150, 161, 180, 191, 250
in vegetable economy, 230
methods for the determination, 64, 211, 231, 236
Nitrometer, Lunge's improved, 203
Nitrous acid, gasometric method of determining, 89
Norton, T. H., and A. Laist, copper antimonide in nature, 138
and E. Twitchell, alloys of calcium and zinc, 143
Nova Scotia, gold mines of, 260

OBITUARY, the late Professor Wroblewski, 201
Odling, W., Address to Institute of Chemistry, 117, 126
W. Crookes, and C. M. Tidy, London water supply, 39, 67, 125, 166, 204, 245
Oil, cotton in olive, detection of, 111, 211
fusel, determination of, 91
of cajeput, 241
of Eucalyptus globulus, 220
of sesame, process for, 192
Oils, action of sulphur and sulphur chloride on, 26, 43
chloride on, 113
"Oils and Fats, Animal and Vegetable" (review), 149
mineral, determination of, 81
in pine, detection, 231
resin, hydrocarbons accompanying diterebenthyl in, 180
with polarised light, action of, 142
"Olfactics and the Physical Senses" (review), 61
Olive oils, sophistications, 170
Onion, chemistry of as a field crop in Australia, 95
Opium, amount of morphia in, 93, 103, 134, 140, 160, 244
Ores, copper, determination of rich, 102
"Organic Analysis" (review), 179
matters, slow combustion of certain, 202
nitrogenous compounds, transformation of nitrates into, 131
Ortho-diketones, coloured reactions of, 222
Osmond, M., absorption of small amounts of sulphuretted hydrogen, 142
F., study of cast-irons, 181
Ostermayer, E., determination of crystalline water, 91
Ouvrard, L., action of alkaline phosphates, 250
Oxalate, analysis of antimonium potassium, 193, 241
Oxalic acid, action on cinchonine, 51
hydrous dissociation of, 106
oxidation of, 168
ether with resorcine, behaviour of, 13
Oxide of manganese soluble in water, 112
of zinc, supposed dissociation of, 175
Oxides, action of certain, 150
of manganese, action of roasting on several, 141
Oxygen acid of sulphur, 150
and hydrogen, relative densities between, 73
spectra, 181
Oxyhydrogen flame, spectrum of, 53

PALM., R., quantitative analysis of the constituents of milk, 81

Paper, examination of, 92
"Paper Making" (review), 21
Paraphenylene-diamine, 262
Paratoluidine, determination of small quantities of, 262
Parsons, C. A., experiments on carbons at high temperatures, 253
Patents, chemical, at Berlin, 192 and reviews, industrial, 151
Paquelin, M., eolipyle, 140
Permanganates, certain novel, 132
Perry, J., and W. E. Ayrton, governing of electromotors, 228
incandescent lamps, 90
magnetic circuit in dynamo machines, 109
measurement of the coefficient of expansion by heat, 210
Perrey, A., and P. Hautefeuille, mineralising action of alkaline sulphides, 101
Perseite, 191
Peter, M., action of oils with polarised light, 142
Peters, E. D., jun., "Modern American Methods of Copper Smelting" (review), 22
Petet, P., formation heat of aniline, 180
Petit, P., azo-derivatives of benzene, 262
Pfeiffer, F., and A. Popper, atomic weight of antimony, 102
"Pharmacy, Year Book of" (review), 39
Pharmakolite, reproduction of, 187
Pheno-safranine, researches on, 141
Phenol, detection of, 102
in crude carbolic acid, proportion of, 92
Phenols, 70
Phenylhydrazine, action of, 168
on an unsaturated diketone, 60
Phenylisobutyric acid derivatives, 168
Phipson, T. L., note on some Chinese dyed silks, 203
Phloroglucine, micro-chemical detection of, 71
Phosphates, ferric alumina, 51
Phosphoric acid of superphosphates, soluble, 63
and moisture, methods for determining, 17
determination of, 211, 222
determination of soluble, 15
and sulphuric acids, estimation of, 165, 187
Phosphorus and phosphoric acid in vegetation, 140
and sulphur in plants, &c., condition and determination of, 31
influence of on the estimation of chromium in iron and steel, 153
Phosphorus pentachloride, 90
action on acetanilide, 255
"Photographic Almanac" (review), 40
Phylloxera, a struggle against by means of maize, 141
"Physical Senses, Olfactics and" (review), 61
Physical Society, 49, 67, 90, 109, 159, 178, 209, 228, 248
Pickering, S. U., constancy in the heat produced by the reaction of certain salts, 75
nature of solutions, 116
solution, 220
thermo chemical constants, 167
Picric acid, various modes of the explosive decomposition of, 23
Piesse, C. H., "Olfactics and the Physical Senses" (review), 61
Piffard, M., colour of bricks, 80
Pilocarpine, synthesis of, 132
Polarimeter, dispersion, 212
Popper, A., and F. Pfeiffer, atomic weight of antimony, 102
Potash, methods of determining, 28
Potassium and sodium, volumetric determination, 214
carbonate, sodium, 181
determination of two rays of, 140
fluoride, &c., preparation of, 111
Potential dynamo machine, condition of self regulation in a constant, 209
Potilitzin's law of mutual displacement of chlorine and bromine, 88
Pouchet, A. G., phenols, 70
Precht, H., and F. Röttger, determination of small quantities of sodium chloride, 251
Preliminary notes, 78
Prescott, A. B., "Organic Analysis" (review), 179
Pringle, A., new elements, 180
Propane, derivatives of, 111
Proteic and albumenoid matters, synthesis of, 220
Propio-propionic ether, constitution of, 12
Pterocarpine and homopterocarpine, 111
Ptomaines, study of, 150, 250
Purdie, T., and W. Marshall, action of alcohols, 90
Pyrogallic acid, detection of, 222
Pyrophosphorous acid, existence of, 220

QUANTIN, H., action of carbon tetrachloride, 180
Quartz conglomerate, examination of, 76
Quercitin and rutin, supposed identity, 60
Quinone, carboxy-derivatives of, 117

RADIO-MICROMETER, 200
Raikon, P., apparatus for continual washing, 221
Raimondi, M., differences in the reactions of strychnine and gelsemine, 251
Ramsay, W, molecular weights of nitric peroxide and nitrous anhydride, 197
Rawson, C., detection of magenta, 165
valuation of indigoes, 7, 19, 29, 34
Rayleigh, Lord, relative densities of hydrogen and oxygen, 73
Redwood, B., and A. G. Salamon, Institute of Chemistry, 80
Refraction, limit of, 67
Refrigerator, 221
Reid, A., F., measuring liquids by drops, 39
Reitmar, O., and A. Stutzer, nitrogen process, 231
Remelé, A., separation of uranium from alkaline earths and alkalies, 221
Renard, A., hydrocarbons accompanying diterebenthyl in the resin oils, 180
"Resistance," note on the use of the term, 68
Resorcine, behaviour of oxalic ether with, 13
"Revenue, Report of the Commission of Internal" (review), 40
Rhodium sesquichloride, 180
Richards, H. C., and H. Smith, "Merchandise Marks Act, 1887" (review), 230
T. W., experiments on metallic chlorides, 16
Ricketts, P. de P., and S. H. Russell, "Skeleton notes on Inorganic Chemistry" (review), 240
Ridsdale, E. A., "Inorganic Evolution" (review), 190
Ridsdale's simplified chronometer for moderately deep tints, 77
Rimington, E. C., measurement of power supplied to the primary coil of a transformer, 109
Rochelle salt, action of on metallic hydrates, 223
Rock salt mines of Petite Anse, 234
Rocques, X., detection of impurities in alcohols, 202
Rodger, J. W., and T. E. Thorpe, Potilitzin's law of mutual displacement of chlorine and bromine, 88
Roozeboom, B., formation of hydrates of gases, 202
Roscoe, H. E., and C. Schorlemmer, "Treatise on Chemistry" (review), 68
Roses, spermaceti in oil of, 263
Roth, C. F., determination of melting-points, 81
Röttger, F., and H. Precht, determination of small quantities of sodium chloride, 251
Rousseau, G., and J. Bernheim, production of crystalline ferric hydrates, 241
Roux, L., and E. Louise, vapour density of aluminium methyl, 121
Royal Institution, 128, 132, 139, 180, 189, 210, 229
Society, 199, 238
of Canada, 259
Rubies, artificial production of rhombohedric crystals, 121
Rücker, A. W., range of molecular forces, 58, 96, 105, 114, 123, 136, 144, 155
and C. V. Boys, optical demonstration of electrical stress, 50, 199
and T. E. Thorpe, note on some additions to the Kew magnetometer, 249
Ruffle method for the determination of nitrogen, 66
Ruhemann, S., and D. J. Carnegie, action of acetone, 117
and S. Skinner, action of phenyl-hydrazine, 168
Russell, S. H., and P. de P. Ricketts, "Skeleton Notes on Inorganic Chemistry" (review), 240
Ruthenium, researches on, 51, 80, 241
Rutin and quercitin, supposed identity of, 60

SABATIER, P., speed of transformation of meta-phosphoric acid, 51
Saccharic and mucic acids, derivatives of, 161
Saccharine, 52, 141
Saccharomyces ellipsoideus, 131
Safe, Is a safe now? 121, 130
Saffranines, 152, 161
Saglier, A., compounds of cuprous chloride, bromide, and iodide with aniline, 219
Salomon, A. G., and B. Redwood, Institute of Chemistry, 80
Salomons, D., "Management of Accumulators and Private Light Installations" (review), 100
Salicylic acid, detection of, 222
colorimetric determination of, 262
Saline fodder plants, Australian, indigenous, 33
Saline matters, absorption of by plants, 150, 161
Salkowski, E., detection of hyposulphurous acid in urine, 71
Salt mines of Petite Anse, 234
Salts, constancy in the heat produced by the reaction of certain, 75
ferric, titration of, 148
of cobalt and nickel, sulphuretted hydrogen for purifying, 55
Salzer, T., determination of ash, 212
Sanson, M., and M. Henninger, glycol in the products of the alcoholic fermentation of sugar, 62
Sarrau, M., and M. Vieille, influence of molecular approximation on the chemical equilibrium of homogeneous gaseous systems, 28
Scale, crystalline, analysis of, 3
Schift, H., colour bases from furfurol, 12
Schlickum, O., delicate detection of arsenic, 221
Schlœsing, T., fixation of nitrogen, 191
relations of atmospheric nitrogen to vegetable mould, 150, 161, 170, 181
slow combustion of certain organic matters, 202
Scholvein, L., impurities in chloroform, 102
Schorlemmer, C., and H. E. Roscoe, "Treatise on Chemistry" (review), 68
Professor, 225
Schunck, E., supposed identity of rutin and quercitin, 60
Schützenberger, P., synthesis of the albumenoid and proteic matters, 220
Schwackhofer, F., manufacture and adulteration of beer, 23
Schweissenger, C., separation of magenta from the colouring-matter of orchil, 263
"Science, Playground of" (review), 69
"Scientists' Directory" (review), 219
Selenites, certain, 121
Selenium, action of light on, 202
detection and estimation of, 16
dioxide, compounds of ammonia with, 163
"Sell's Dictionary of the World's Press and Advertising Reference Book" (review), 210
Sesame, process for oil of, 192
Sesquichloride of rhodium, 180
Sesquisulphide of rhodium, 241
Sewage, oxidation of. 256
"Sewage Treatment" (review), 9
Seyffart, J., dispersion polarimeter, 212
Shenstone, W. A., and J. T. Cundall, influence of temperature on the composition and solubility of hydrated calcium sulphate, 167
Silberbach, J. H., "Handbook of Mineral and Vegetable Products of all Countries" (review), 69
Silicates, the natural, chemical structure of, 176, 188
Silicon, 54
an alloy of titanium and aluminium with, 51
Silks, note on some Chinese dyed, 203
Silver, effect of bismuth on, 191, 192
oxidation of, 142
Simon, A., pipette far measuring bromine, 250
Skinner, S., and S. Ruhemann, action of phenyl hydrazine 168
Slags, lead, 4, 18, 37, 43, 57
metallic, iron in, 171
Slater, J. W., "Sewage Treatment, Purification, and Irrigation" (review), 9
Slatter, G. W., "Qualitative Analysis" (review), 179
Smith, H., and H. C. Richards, "Merchandise Marks Act" (review), 230
J. D., and E. F. Teschemacher, amount of morphia in opium, 93, 103, 160, 244
W. J., and T. E. Thorpe, morindon, 48
Soap, soft bleaching, 102, 112

Soap bubbles, 160, 200, 238
powders, examination of, 71
"Soap and Candles" (review), 261
Society, Chemical, 8, 48, 58, 87, 106, 115, 147, 167, 196, 206, 216, 226, 246
Industrial, of Mulhouse, 141, 151, 191, 192
Physical, 49, 67, 90, 109, 159, 178, 209, 228, 248
Royal, 199, 238
of Canada, 259
Soda-lime method for the determination of nitrogen, 66
Sodium and potassium, volumetric determination of, 214
chloride, determination of small quantities of, 251
disulpho-persulphate, properties of, 211
potassium carbonate, 181
Soils, absorbent power of, 101
virgin, of Australasia, exhaustion of, 25
Solids, table of the cubical expansion of, 259
Solution, 179, 220, 249
Solutions, nature of, 116
Somalis, crystalline matter of the poisoned arrows of, 167
Soxhlet's apparatus, improved modification of, 56, 91, 130
Specific gravity of liquids, method of finding, 138
Spectra experiments illustrating low temperature, 200, 239
of oxygen, 181
Spectrum of the oxyhydrogen flame, 53
Spermaceti in oil of roses, detection of, 263
Spike, lavender, essence of, 111
Spring, W., speed of the reaction of Iceland spar with acids, 263
study of the formation of coal 263
and G. de Bœck, colloidal copper sulphide, 111.
and A. Lecrenier, constitution of Guthrie's chlorised ethyl disulphide, 152
preparation of some novel chlorine derivatives, 151
magnifying, 39
St. Edme, E., passive state of iron and nickel, 180
Starch, iodide of, 183
Steam-calorimeter, 250
Steel, determination of carbon in, 27
Stephen, J., playground of Science, 69
Stevenson, T., "Treatise on Alcohol" (review), 179
Stocks, H. B., iodide of starch, 183
Stokes, A. W., combustion apparatus, 150
Stoney, G. J., logarithmic law of at mic weights, 163
Stormer, R., reaction of thymol 220
Streatfeild, F. W., and R. Meldola, constitution of azo- and diazo-derivatives, 217
Strontium, barium, and calcium, determination of, 221
Strychnine and gelsemine, differences in the reactions of, 251
Stuart, C. M., phosphorus pentachloride, 90
Stutzer, A., and A. Isbert, determination of phosphoric acid, 211
and O. Reitmar, nitrogen process, 231
Sugar, inactose in neutral, 170
obtained from agar-agar, 82
Sugars of hesperidine and isohesperidine, 263
Sulphate, hydrated calcium, 167
Sulphates and chlorides in aqueous solution. Is there a constant relation between the heats of formation of? 36
decreasing solubility of, 62, 141
Sulphide of cadmium, 150
Sulphides, alkaline, mineralising action of, 101
Sulphonation of naphthalene, 9
Sulphur and alum-stone in New South Wales, 64
and phosphorus in plants, &c., condition and determination of, 31
chloride in oils, action of, 26, 43, 113
oxygen-acid, 150
vapour on metallic copper, action of, 95
Sulphuretted hydrogen, absorption of small amounts, 142
generating pure, 81
solution, preservation of, 173
Sulphuric and phosphoric acids, estimation of, 165, 187
anhydride, new lecture apparatus for making, 193
Sumpner, W. E., variation of the coefficients of induction, 159
Szymanski, F., detection of albumenoids in wheat grains, 71

TANNIN, 214, 242
Tanret, C., oxidation-products of the hydrazo-camphenes, 131, 141
sugars of hesperidine and isohesperidine, 263
Tartaric acid, determination of, 250
malic, and citric acids, distinction between, 230
Taylor, A. B., method of finding the specific gravity of liquids, 138
J. T., "Photographic Almanack" (review), 40
Technical College, Finsbury, 196
terms, French, 252, 262
"Technical Instruction and Revised Catalogue of Apparatus" (review), 69
Telegraphic purposes, use of E.P.S. storage batteries, 51
Tellurium, specific heat of, 32
Terpinol, 131, 211
Terpilenols, action of acids and anhydrides on, 181
Teschemacher, E. F., and J. D. Smith, amount of morphia in opium, 93, 103, 160, 244
Tetramethyl-ammonium, action of heat on the salts of, 198
phosphonium, action of heat on the salts of, 198
Thalleioquin reaction, 251
Thalline and antipyrine, behaviour of, 102
Thermo-chemical constants, 167
Thomson, W., Institute of Chemistry, 50, 79, 110, 120
Thompson's calorimeter, 161
Thompson, S. P., condition of self-excitation in a dynamo-machine, 209
Thomson, S. P., formula of Bernoulli and Haecker for the lifting-power of magnets, 229
graphic treatment for the Lamont-Frolich formula for induced magnetism, 178
water dropping influence machine, 50
Thorpe, T. E., apparatus for the isolation of the element fluorine, 200
and F. J. Hambly, manganese trioxide, 48
and J. W. Rodger, Potilitzin's law of mutual displacement of chlorine and bromine, 88
and M. Rücker, note on some additions to the Kew magnetometer, 249
and W. J. Smith, morindon, 48
Thymol, reaction of, 220
Tidy, C. M., "Handbook of Modern Chemistry" (review), 219
W. Crookes, and W. Odling, London water supply, 39, 67, 125, 166, 204, 245
Tin from antimony, separation, 124
ore, opening up, 221
Titanium and aluminium with silicon, an alloy of, 51
Topf, G., iodometric studies, 62
Tomasi, D., ferric hydrates, 181
Tomlinson, C., on bumping ebullition, 244
H., effect of magnetisation on the thermo-electrical properties of bismuth, 49
experiments with nickel, 90
sudden loss of magnetic properties of iron and nickel, 178
Terrey, J., simple method for determining equivalents, 166
Transformer, measurement of power supplied to the primary coil of, 109
Trichloric alcohol, 171
Triocyanates on aldehyde-ammonias, action of, 116
Triothionate of sodium, crystalline form, 211
Tubes, pressure, their use and construction, 155, 211
Turner, T., apparatus for determining the hardness of metals, 200
Turpentine, action of formic acid on French oil of, 51
Twitchell, E., and T. H. Norton, alloys of calcium and zinc, 143

ULLBRICHT, R., and E. Meissl, original standard for volumetry, 81
University College, Aberystwith, 24
Dundee, gift of a museum to, 71
Uranium, separation from alkaline earths and alkalies, 221
Uric acid, determination of, 243
Urine, detection of hyposulphurous acid, 71
diabetic, determination of sugar in, 102
"Urine, Various Modes for Testing for albumen in" (review), 68

VAN DER PLAATS, J. D., re-calculation of the results of the determinations of Stas, 71
Vanadic acid, action of, 70
Vanadium, detection of, 83
"Vegetable and Mineral Products of all Countries" (review), 69
Veley, V. H., evolution of gases from homogeneous liquids, 233
Venator, W., recovery of molybdenum residues, 81
Verneuil, A., and E. Fremy, artificial production of rhombohedric crystals of rubies, 121
Vieille and Sarrau, MM., influence of molecular approximation on the chemical equilibrium of homogeneous gaseous systems, 28
Vignon, L., determining carbonic acid in solution, 12
paraphenylene diamine, 262
separation of iron oxide and alumina, 221
and M. Barbier, new method of forming substituted saffranines, 152, 161
researches on pheno-safranine, 141
Villard, M., certain novel hydrates of the gases, 242
and M. de Forcrand, formation of the hydrates of gases, 161
hydrated methyl chloride, 211
Villiers, A., a new oxygen-acid of sulphur, 150
properties of sodium disulphopersulphate, 211
Vincent, M. C., and M. Delachanal, new carbohydrate, 111
Virgin soils of Australasia, exhaustion of, 25
Vitriol chamber process, theory of, 49, 69
Vivier, A., analysis of the nitrites, 33
novel hydrate of molybdic acid 121
Voelcker, E. W., Institute o Chemistry, 80
Voiry, R., oil of cajeput, 241
oil of Eucalyptus globulus, 220
and G. Bouchardat, essence o spike lavender, 111
terpinol, 131, 211
Volumetry, definition of norma solutions for, 62
original standard for, 81
Voltaic couple, effect of chlorine on the electromotive force of 184
Voltaic couple, minimum point o change of potential of, 254
Von Aubel, M. E., influence of magnetism, 50
Von Knorre, G., separation of metals, 24
Von Richter, V., "Text-Book of Inorganic Chemistry" (review), 139
Vortmann, G., detection of small quantities of hydrocyanic acid, 231
Vulpius, G., thalleioquin reactions, 251
Wackenroder's solution, chemical investigation of, 87
Waller, E., and H. C. Bowen, determination of nitrogen, 236
Walls, dryness of, 101
Warren, H. N., action of Rochelle salt on the metallic hydrates, 223
action of sulphur vapour on metallic copper, 95
aluminium in iron, 261
detection and estimation of selenium in meteoric iron, 16
electro-crystallisation of metallic copper, 184
pressure tubes, the use and construction of, 155
recent investigations on the fulminates, 255
separation of tin from antimony, 124
the element silicon, 54
T. T. P. B., action of sulphur and sulphur chloride on oils 26, 43, 113
analysis of mixed paints, 31
electrification and electrolysis 143
French technical terms, 262
is a safe a safe now? 130
Warington, R., chemical action o some micro-oganisms, 246
Washing, apparatus for continua 221
Water, crystalline determination of, 1
alcohol in, 232, 242
analysis, 212
of bad, 171
dropping influence machine, 50
supply, London, 39, 67, 125, 166 204, 245
Waters, mineral, neutral determination of carbonic acid in 250
refuse, purification of, 32
"Watts's Dictionary of Chemistry" (review), 169
Watt, G., "Report on Indian Fibres" (review), 129
Waves, height, length, and velocity of ocean, 90
Weights, atomic, logarithmic law of, 163
molecular, of nitric peroxide and nitrous anhydride. 197
of the carbohydrates, 196
Weil, F., volumetric process for determining the grey zinc powder of Vieille Montagne, 12
Welding and brazing, new departure in, 40

Weller, A., detection of bromine, 251
Welsh gold mining, 252
Werner, E. A., oxidation of oxalic acid, 168
researches on chromorganic acids, 108
"Wheat, Barley, &c., Experiments on the Growth" (review), 129
grains, detection of albumenoids, 71
White, J. T., volumetric estimation of sulphuric and phosphoric acids, 165, 187
determination of potassium and sodium, 214
Whittaker, W. .and W. H. Dalton, "Geological Record" (review), 169
Wiesbaden, chemical laboratory at, 112
Williams, R., determination of the amount of morphia in opium, 134
W. C., and L. Meyer, "Modern Theories of Chemistry" (review), 119
Williamson. Professor, 233
S., and H. E. Armstrong, isomeric change in the naphthalene series, 9
Wimshurst, A. J., large electrical influence machine, 199, 238
Winckler, C., generating chlorine gas, 82
A., atomic weight of germanium, 71
Winssinger, C., derivatives of propane, 111
Wines, preservation of, 111
Winter H., levulose, 191
Wood, G., action of light on selenium, 202
decaying, colouring-matters, 122
Wrightine and conessine, 251
Wroblewski, the late Professor, 201
Wurster, C., examination of paper, 92
Wurtz, R., volatile bases in blood, 62
Wynne, W. P., and H. E. Armstrong, isomeric change in the naphthalene series, 8, 9

YEAST, pure, culture of, 23

ZINC and cadmium alloys, 143
aluminium, iron, cobalt, nickel, and manganese, separation of, 125
chloride, 232
oxide, supposed dissociation of, 175
powder of Vieille Montagne, volumetric process for determining the grey, 12

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PHENOL AND SOME ALLIED BODIES AS TESTS WITH CONCENTRATED SULPHURIC ACID FOR NITRITES, NITRATES, AND CHLORATES IN AQUEOUS SOLUTION.

By DAVID LINDO.

THE fact that highly characteristic coloured products are formed when nitrites or nitrates are mixed with some of the phenols in the presence of concentrated sulphuric acid, may be utilised for the purpose of identifying the members belonging to either class of bodies. Nevertheless, although the oxides of nitrogen are often employed as tests for some of the phenols, few of these reactions have been made available for the purpose of identifying nitrates and nitrites in solution, nor have they been suited, so far as I am aware, as to their delicacy and general fitness, for such a purpose.

Sprengel, some years back, proposed carbolic acid as a test with sulphuric acid for nitrates. The test, as described by Fresenius and others, will not distinguish between a nitrate and nitrite, and according to the directions given, it is to be applied to the dry residue.

I have recorded in this paper the results of experiments made with carbolic acid, orcinol, thymol, and α-naphthol. The two last will be dealt with briefly, for they were found of little value as reagents for the detection of nitrogen oxides, and of no value as tests for the oxides of chlorine.

Reagents.

Carbolic Acid.—Calvert's No. 1. 10 c.c. of the fused crystals placed in 100 c.c. flask, some water added, then 25 c.c. 97 per cent alcohol, and made up to the mark with water.

Orcinol.—This was in good crystals, almost colourless. 5 grms. dissolved in water and made up to 100 c.c.

Thymol.—10 grms. of good clear crystals dissolved in 97 per cent alcohol and made up to 100 c.c.

α-Naphthol.—1 grm. dissolved in alcohol and made up to 100 c.c.

Sulphuric Acid.—Pure, sp. gr. 1·837 at 26° C. (a stronger acid spurts too much). This is the sp. gr. of commercial pure acid.

Solutions.

Potassic Nitrate.—1·8723 grms. of the pure salt dissolved in water and made up to 100 c.c. Call this N_2O_5 dilution 100.

1·8723 grms. dissolved in water and made up to 20 c.c. Call this N_2O_5 dilution 20.

Sodic Nitrite.—0·4053 grm. pure silver nitrite dissolved in 100 c.c. boiling water. Added 0·1600 grm. pure NaCl dissolved in a little water; transferred to 200 c.c. flask; when cold, made up to the mark, agitated, let settle, and filtered through dry filter. 0·154 NaCl was required for exact precipitation, but 0·006 grm. excess used to ensure complete reaction. Call this N_2O_3 dilution 2000.

Potassic Chlorate.—1·624 grms. of the pure salt dissolved in water and made up to 100 c.c. Call this Cl_2O_5 dilution 100.

These solutions were further diluted as required.

Method.

In *all* experiments 0·5 c.c. of the solution to be tested was taken for each test. To this was added *one* drop of phenol, thymol, or α-naphthol solution, but of the orcinol *two* drops were added to the 0·5 of solution to be tested, except in testing for chlorates, when *one* drop was used. Two c.c. of sulphuric acid taken for each test in *all* cases. Tubes $\frac{9}{16}$ to $\frac{5}{8}$ inch diameter were employed.* The tube rack was provided with a wooden slide covered with white paper; this was placed behind the tubes. The solutions were delivered from a 1 c.c. scale pipette graduated into 100 parts, the reagents from drop tubes with small apertures, and the sulphuric acid from a burette. The solution was placed in tube, reagent added, and sulphuric acid run in, the point of burette resting on inner surface of tube, which was slightly inclined so that the acid might reach bottom with as little disturbance as possible; the tap of burette was turned on full.† After acid was run in, the tubes, with white background, were placed in front of a good light, so that the colour reactions might be properly observed. These taking place at the junction of the two liquids, bands of colour, often of great beauty and very characteristic, were produced; the bands at first were generally narrow and sharp, but increased greatly in breadth and depth of colour after a time.

Three or four tests at each dilution were made together, and a blank with the acid reagent and distilled water at the same time, until the purity of the sulphuric acid was placed beyond doubt. All experiments, results of which are here recorded, have been repeated several times; the temperature at which they were made averaged about 26° C., and this should be borne in mind, since it is possible that the delicacy of the orcinol test especially might not be so great at a lower temperature as I have found it to be at 26° or thereabout.

I have studied the colour reactions produced by the

* Inside measurement, not across the lip.

† The burette should be kept pretty full, so as to give sufficient pressure to ensure a quick flow, otherwise the bands, instead of being sharp and strong, will be diffused and weak; this, at high dilutions, mars the reaction.

phenols and sulphuric acid with nitrites, &c., and the influence of some other bodies in modifying these reactions.

Detection of nitrites, nitrates, and chlorates in presence of each other. Colour reactions produced by oxidising agents free from nitrogen with phenol and orcinol.

TABLE I.—PHENOL AND NITRITES.

N_2O_3 dilution.	Reaction.
200,000	Faint pink band at first, faint green below. Half an hour, pink band very distinct. 5 hours, the colour had faded away.
50,000	Good red and green bands at once. 1 hour, very fine. 5 hours, much lighter.
10,000	Splendid red and green bands at once. 24 hours, the green band had disappeared, replaced by blue. Red changed to dingy purple.
2000	Very intense red and green bands. 24 hours, blue band in place of green. Red to dingy purple.

(*Remarks.*—200,000 seems about the limit for definite reaction. At 400,000 the bands were very faint. The conversion of green band to blue is not always apparent at 10,000, at 2000 it is always observed; in all cases, only after a long interval).

TABLE II.—ORCINOL AND NITRITES.

N_2O_3 dilution.	Reaction.
1,000,000	At first nothing. After 9 hours, extremely faint pink. 24 hours, no better.
500,000	At first nothing. After 4 hours, very faint pink. 9 hours, more distinct. 24 hours, no better.
200,000	At first nothing. 20 minutes, very faint pink. 4 hours, fairly distinct. 9 hours, distinct pink, orange tinge. Not strong, 24 hours, no better.
10,000	Strong orange-band at once. After some time almost opaque.
2000	As above but stronger.

(*Remarks.*—The colour is permanent. 500,000 must be taken as the limit; even at that the colour is very pale. At 1,000,000 the reaction is much too faint to be reliable).

Several tests besides those given in the tables were made with intermediate strengths of N_2O_3 with phenol and with orcinol, but it is considered the examples given will suffice. With nitrites I have not gone lower than a dilution of 2000 N_2O_3; results show one drop phenol or two drops orcinol suffice to give intense characteristic bands with 0·5 c.c. solution at this dilution, and experiment has shown the reactions are quite as good (with orcinol better) at high dilution with these quantities of reagents, of the strengths given, as with the same quantities of weaker phenol and orcinol solutions.

Thymol.

Thymol is a poor test for nitrites in aqueous solution. At 50,000 N_2O_3 very faint bands were obtained, and even at 2000 the red was weak and streaky. For the detection of nitrates it is still less fit; morever, oxidising agents free from nitrogen give a red band with this reagent; for example, chlorates and hydroxyl.

α-Naphthol.

This phenol gives a green band with nitrites and nitrates; the reaction is delicate, but does not appear due to formation of a nitro-compound; at all events, oxidising agents containing no nitrogen also give a green band under the conditions of the experiment; even sulphuric acid, though pure, will do so if sufficiently strong, when it is added to a little water and the reagent. If the solution of nitrates is very strong a dingy red band is seen.

TABLE III.—PHENOL AND NITRATES.

N_2O_5 dilution.	Reaction.
20,000	Practically no reaction.
10,000	Faint pink band. 2 hours, band broader, but colour less definite. 4 hours, colour fading.
2000	Pretty strong red band, not brilliant, light green below. 2 hours, band broader but colour dingy.
1000	Intense red band, pale green below. 2 hours, very dense. 4 hours, about the same.
100	Very intense red inclined to brown. 4 hours, more brown than red.
20	Strong effervescence with ruddy fumes. Broad yellowish band below narrow light vermillion band. 2 hours, yellow now orange, vermillion band diffused, and colour lighter. 4 hours, about the same.

(*Remarks.*—These results would indicate that phenol is a poor test for nitrates; the colours are not brilliant and the test is very deficient in delicacy. It will be shown further on, however, that this imperfect action of the reagent, when used for the detection of nitrates with the addition of sulphuric acid alone, is in fact a point in its favour).

TABLE IV.—ORCINOL AND NITRATES.

N_2O_5 dilution.	Reaction.
20,000	Faint yellow, but no definite reaction even after standing 9 hours.
10,000	Faint orange band, not much stronger after 9 hours.
2000	Orange band very distinct, improved on standing.
1000	Sharp orange band, colour deep but not brilliant.
100	Intense orange after 9 hours, colour not so deep but more brilliant.
20	Slight effervescence, no ruddy fumes, orange intense but not quite as deep as 100. 9 hours lighter, but more brilliant.

(*Remarks.*—The remarks to Table III. apply here also also, except that very strong solutions give brilliant bands with orcinol, which may be considered more characteristic than the phenol bands with the same strength of nitrate. It is hardly necessary to say that if a larger quantity of reagent is used with these concentrated solutions of nitrate, the results will be very different to those here recorded. With phenol the reaction will be very violent.)

Phenol and Chlorates.

Although carbolic acid is of little or no value as a test for chlorates, I have considered it best briefly to describe the reactions. At 10,000 Cl_2O_5 a light yellow band is seen, blue below; the latter soon fades. At 4000 the blue soon changes to dingy green. At 2000 muddy orange soon turns brown; dingy blue below soon changing to dingy green. At 1000 and higher strengths no blue observed. The chlorate evidently merely acts as an oxidising agent, yet other oxidisers, such as chromic acid and hydroxyl, give no blue band with phenol.

The Influence of Some Other Bodies on the Reactions.
Hydrochloric Acid.

Three strengths of solution were employed.

a. Containing 26·16 per cent HCl.
b. Consisting of *a* and an equal volume of water.
c. Containing 4·88 per cent HCl.

The HCl was always added in testing before running in the sulphuric acid. Tests made without HCl at the same time for comparison.

Table V.—Orcinol and Chlorates.

Cl_2O_5 dilution.	Reaction.
100,000	Faint blue band transient.
50,000	Blue more distinct, still transient.
20,000	Blue more distinct; after a little time, very faint pink above.
10,000	Beautiful blue band, soon acquires all the colours of the rainbow. Tolerably permanent.
4000	Intense blue band; below rather deep green; rainbow effect, therefore, not so good as 10,000.
2000	Intense blue, soon turns green.
1000	Intense green, soon turns brown.
100	Light yellow only.

(*Remarks.*—This fine colour reaction, although, no doubt, merely the result of oxidation, has not been obtained by me as yet with any oxidisers but chloric acid. Some of the lower oxides of chlorine and chromic acid (1 grm. potassic dichromate in 1 litre of water and weaker). If these results are confirmed orcinol will prove a characteristic as well as a delicate test for oxides of chlorine (not perchloric acid) and chromates.* Hydroxyl and permanganates give compound coloured bands of an entirely different character; these reactions will be described further on).

Nitrites.

Phenol.—One drop *c* seemed merely to retard reaction. After standing a short time it was impossible to distinguish the tests with HCl from those without it. One drop of *a* caused reaction to be indistinct at 200,000 N_2O_3 and much weaker at 100,000 (though distinct) than the tests without HCl. Two drops of *a* caused reaction, even at 50,000, to be indistinct, and with this quantity no green, but a yellow lower band, was seen as low down the scale as 20,000. At 10,000 light red band was obtained, yellowish green below.

Orcinol.—Two drops of *a* produced no appreciable effect at high dilutions, but at 10,000 and lower down, one drop of *a* made a very sensible difference, the bands being weaker than without HCl, though they were still strong; the colour also not so pure.

Table VI.—Phenol, Nitrates, and HCl.

1 drop of HCl *c* to each test.

N_2O_5 dilution.	Reaction.
100,000	Faint pink at once. 20 minutes, distinct. 3 hours, broad band distinct. 8 hours, colour gone.
50,000	As above but stronger.
10,000	Sharp crimson band at once, increased in breadth without losing intensity for some hours. Faint green below, this soon faded.
5000	As above but much stronger.
1000	Very dense red, green below.
100	Intense red soon turned brownish, narrow vermillion band below.
20	Effervescence, then broad light orange band.

(*Remarks.*—100,000 appears about the limit. Results show that, in the presence of HCl and sulphuric acid, phenol becomes a delicate and characteristic test for nitrates in aqueous solution, whereas, without HCl, it is of little value. Reaction with HCl was better at 100,000 than at 10,000 without it (tested alongside). Very large excess of HCl greatly lowers the intensity of the bands, yet with 1 drop of *a*, good reactions were obtained at high or low dilution of N_2O_5. It developed the green band better than HCl *c*. It has been shown that with nitrites HCl tends to suppress the green. 2 drops of *a* to 0·5 c.c. nitrate gave irregular results, reaction being sometimes very good, at others indifferent at the same dilution of N_2O_5. With this quantity of HCl there is strong effervescence on adding the sulphuric, which tends to prevent the formation of sharp bands).

* Chlorine water will probably give the same reaction.

Table VII.—Orcinol, Nitrates, and HCl.

1 drop HCl *b* to each test.

N_2O_5 dilution.	Reaction.
500,000	After 3 hours, extremely faint pink. 9 hours, more distinct; after that no perceptible improvement.
200,000	After 3 hours, faint pink. After 9 hours, sufficiently distinct pink with very faint tinge of orange.
100,000	As above but stronger.
50,000	Faint band almost immediately; on standing improved as usual, orange more pronounced than above. After 9 hours, fairly strong band.
10,000	Fine orange band at once. After 3 hours, beautiful brilliant band.
1000	Dense orange band.
100	Effervescence, then turbid orange band.
20	Strong effervescence, turbid orange band.

(*Remarks.*—Although orcinol, in presence of HCl and sulphuric acid, is undoubtedly a more delicate test for nitrates than carbolic acid, the bands at high dilutions are weak, and take a long time to develope; the colour, however, is permanent. As a reagent for the detection of traces of nitrates in presence of very large quantities of HCl or chlorides, it is very superior to phenol. Much larger excess of HCl than was here employed may be present without interfering with the delicacy of the reaction).

Phenol, Chlorates, and HCl.

The colour reaction, such as it is, does not occur, or occurs very imperfectly in presence of HCl.

Orcinol, Chlorates, and HCl.

1 drop of HCl *c* made no appreciable difference until a concentration of 20,000 Cl_2O_5 was reached. Slight paling effect at that and lower down the scale. The effect of one drop *a* was more marked, yet a faint blue band was seen at 100,000. At 10,000 the rainbow band, though decidedly weaker than without HCl, was still very distinct.

Note.—After this, whenever it is stated HCl was employed it will be understood that one drop of the strength *b* was added to the test.

(To be continued.)

INFLUENCE OF THE CHEMICAL ENERGY OF ELECTROLYTES UPON THE MINIMUM POINT AND CHANGE OF POTENTIAL OF A VOLTAIC COUPLE IN WATER.*

By Dr. G. GORE, F.R.S.

By means of a zinc-platinum voltaic couple in distilled water, with its electromotive force balanced by that of a suitable thermo-electric pile† (*Birming. Phil. Soc. Proc.*, vol. iv., p. 130), the effect of several groups of chemical substances upon the potential of the couple was examined. Measurements were made of the electromotive forces of a series of strengths of solution of each substance, and the results are given in a series of tables.

The minimum proportions of substance required to change the potential of the couple in water were as follows:—

Potassic iodate.—Between 1 in 443 and 494.
,, bromate.—Between 1 in 344 and 384.
,, chlorate.—Between 1 in 221 and 258.

* Abstract of a Paper read before the Royal Society, June 14, 1888.
† This instrument is manufactured by Messrs. Nalder Bros., Horseferry Road, Westminster.

Potassic iodide.—Between 1 in 15,500 and 17,222.
" bromide.—Between 1 in 66,428 and 67,391.
" chloride.—Between 1 in 695,067 and 704,540.
Iodine.—Between 1 in 3,100,000 and 3,521,970.
Bromine.—Between 1 in 77,500,000 and 84,545,000.
Chlorine.—Between 1 in 1,264,000,000 and 1,300,000,000

On comparing these numbers we find that the proportion of substance required to upset the voltaic balance was largest with the oxygen salts, intermediate with the haloid ones, and least with the free elementary halogens. It was smaller the greater the degree of chemical energy of the substance; thus it was about 400 times less with chlorine than with iodine. And it was smaller the greater the degree of freedom to exert that energy; thus it was about 5,416,000 times less free with chlorine than with potassic chlorate, or 1,570,000 times less than with the combined chlorine of the chlorate, and about 185 times smaller than with potassic chloride, or 88 times less than with the combined chlorine of that salt.

The order or curve of variation of potential by uniform increase of strength of the solution was different with each substance, and was apparently characteristic of the body in each case. A great number of such representative curves might be obtained with a zinc-platinum or other voltaic couple in different electrolytes.

THE ACTION OF SULPHUR CHLORIDE ON OILS, &c.

By THOMAS T. P. BRUCE WARREN.

In examining samples of so-called lard and lard oil, I have felt surprised at the small yield of soluble matter from the coagulum produced by sulphur chloride.

Lard and lard oil, when genuine, yield products which are perfectly soluble in carbon disulphide; so that, if we operate on a mixture consisting of equal parts, say, cotton-seed oil and lard oil, *ut supra*, we may reasonably expect about 50 per cent soluble matter. The adhesion of the lard oil, or retention by imprisonment among the particles of altered cotton oil, reduces the apparent yield as regards lard oil, and increases that of cotton oil. Fortunately, in examining mixtures of this kind, I have invariably confirmed the analytical result by synthetical experiment.

Instead of treating a clammy soft coagulum with carbon disulphide, it is better to treat the same with a moderately strong alkaline solution containing about 30 per cent KHO.

The results obtained are in direct contradiction to a statement in "Watts's Dictionary," article, Linseed Oil, vol. iii., p. 703. It is there stated that "on mixing from 15 to 25 parts chloride of sulphur with 100 parts linseed oil, caoutchouc-like products are obtained, which are harder the more chloride of sulphur they contain, and are not attacked by moderately dilute acids and aqueous alkalies, but *are ultimately saponified by concentrated alkalies*."

When a very concentrated solution is used the coagulum, even on long boiling, does *not dissolve*, but a slimy, gelatinous mass is formed.

A mixture of cotton oil and lard oil, when treated with sulphur chloride, may be almost unmanageable to deal with in the ordinary way, but if boiled with a strong alkaline solution for some time it completely disintegrates, leaving the insoluble portion of the coagulum colourless by repeated washings on a filter, until alkaline reaction ceases. If a non-saponifiable product from lard or lard oil be formed, it can easily be removed by means of ether.

By adding an acid to the filtrate, the fatty acids are separated out. The glycerin determination and the properties of the fatty acids will furnish a clue as to the oils which are present, and do *not* yield solid and insoluble products in carbon disulphide.*

* The glycerin determination is made on the soluble portion recovered from the coagulum.

The following singular result was met with a few days ago, which confirms the value of this procedure. A mixture was made of cotton and lard oils, which did not yield an insoluble product; it dissolved with slight cloudiness in CS_2. This was evaporated, and the residuum treated by the saponification process, when the altered cotton oil was readily separated from the saponifiable oil. This singular result shows that, although an oil or fat may be present in a mixture which prevents the appearance of an insoluble substance in CS_2, we can recover the same if present by saponification. An oil which is, in the ordinary way, acted on by sulphur chloride may be prevented from revealing itself in consequence of the solvent action of other oils present, but although this singular event may happen, it establishes the fact that the reaction has taken place, although the expected coagulum did not appear.

I hope to return to the consideration of this interesting reaction at an early date, with special reference to lard oil and lubricating mixtures.

Some very important results have been obtained on the synthesis of the fatty glycerides, arising from the analysis of mixtures of oils. How far it is possible to confirm Berthelot's observations on the synthesis of oils I can scarcely say; but this fact is certain, we can reproduce from the fatty acids of cotton oil and glycerin a compound closely approaching the original cotton oil. The salient points are, that the purified acids from cotton oils do not yield insoluble products with sulphur chloride, but by treating these acids with glycerin in stout hermetically sealed glass tubes at a temperature of about 500° F. for several weeks, we confirm the reproduction of cotton oil; hence the fatty glycerides are concerned in the reaction due to sulphur chloride, at least in the case of cotton oil.

An interesting application of this part of the process is to reproduce from a sample of blown oil, recovered from a petroleum mixture, the original glyceride, and to establish whether the blown oil used was that of cotton oil or rape oil.

I can now understand why it is that sulphur chloride produces dark and even black products from oxidised oils. It is due, no doubt, to the removal of glycerin. The stability of the fatty glycerides in different oils is one of very great importance, and has more to do with the drying qualities of an oil than seems to be taken account of. The iodine absorption of an oil, before and after exposure to the air in a warm place in vessels, so that the weight of oil and area of surface are identical, will give a very accurate idea of the changes brought about by oxidation. Poppy oil behaves so exceptionably in this respect to other oils that by exposure in an open dish at 140° F. its iodine absorption fell from 135 per cent to 119 per cent in ten days. Rape oil similarly exposed became very much bleached, but fell only about 10 per cent.

A deduction which can hardly be over estimated in its importance to the chemistry of oils is, that so long as we do not upset the chemical composition of the proximate principles of an oil, we can reproduce that oil, and, further, a glyceride already containing a certain proportion of an acid may be made to take up, if not previously saturated, a further proportion of that acid. This fact receives a significance when we consider the relation of cocoa-nut oil and butter fat so far as concerns the volatile acids.

THE GAS BALANCE.

It is well known to chemists and physicists that all the four methods hitherto used for determining the specific gravity of gases, have the drawback that they require much time and skill on the part of the operator, and that one, Wright's aërostatic method, is applicable only to gases lighter than atmospheric air. Mr. Friedrich Lux, however, has succeeded in solving the process by means of his new invention, the gas-balance, the construction of which is shown in fig. 1.

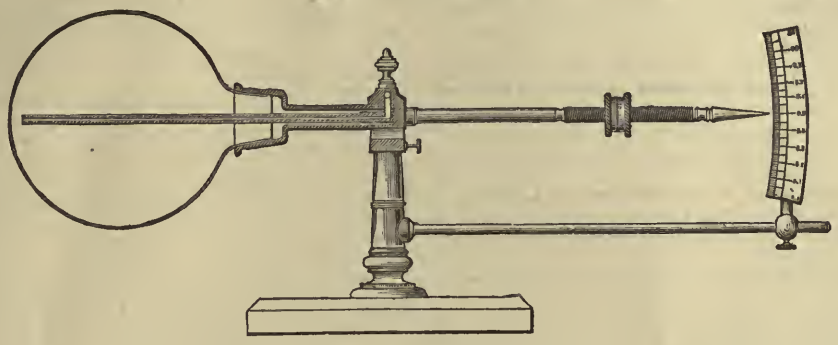

FIG. 1.

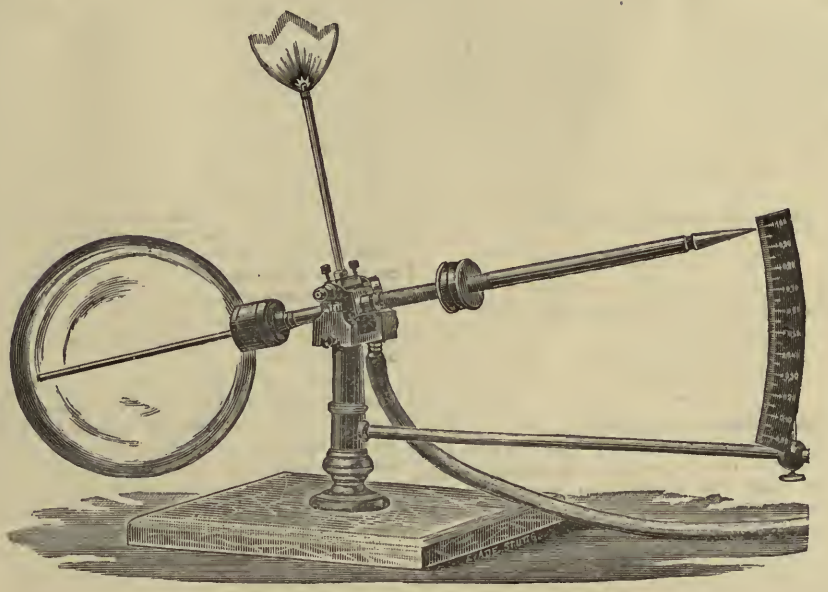

FIG. 2.

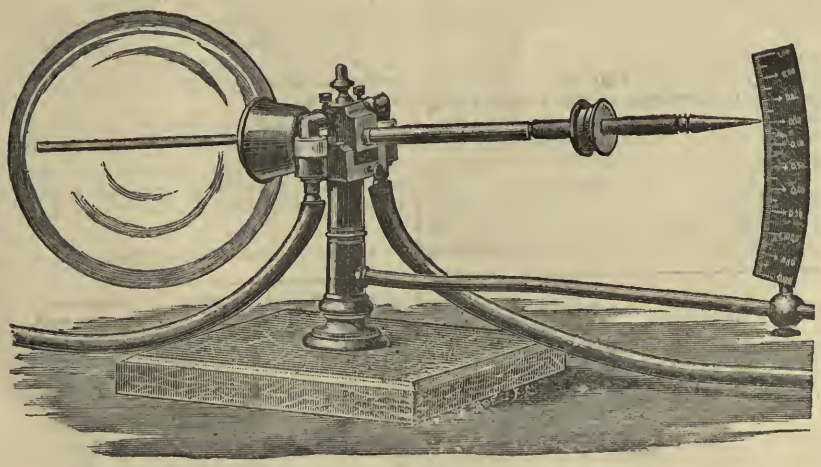

FIG. 3.

The gas in question is introduced into the globe at the left side of the figure, when the index on the right, which is, in fact, the end of the other arm of the balance, moves up or down on the scale according to its specific gravity. The counterpoise, which moves up or down on the right arm, must be so placed that when the globe is filled with air the index points exactly to 1. The globe is then filled with pure hydrogen, and the point then indicated is marked as 0·07. The upper section of the scale is divided into 93 equal parts and the lower into 7. The apparatus can be rendered more or less sensitive by adjusting the respective positions of the centre of gravity and of the point of suspension, for which purpose set-screws are provided. For the special purpose of taking the specific gravity of coal-gas two modifications are shown in figs. 2 and 3.

The balance subserves a densimetric process of gas-analysis which the author has devised. One component of the gaseous mixture after another is withdrawn, as in the ordinary process, and the exact quantity of each is calculated from the specific gravity of the original mixture, of that which remains, and of that which has been withdrawn. To ascertain x parts we must employ $x+1$ gas-balances, with the requisite absorption-vessels inserted between each two. If the specific gravity of the original mixture is S^1, that of the gas withdrawn S^2, and that of the residue S^3, then $S^1 = x\,S^2 + (1-x)S^3$ wherefore $x = \frac{S^1 - S^3}{S^2 - S^3}$

NOTE ON THE

ABSORPTION OF AMMONIA BY ACID SOLUTION IN NITROGEN DETERMINATIONS WITH SODA-LIME.

By I. S. HAYNES.

Among the possible sources of error in the determination of nitrogen by the method of Varrentrapp and Will is the failure of the ammonia to be completely absorbed by the acid solution, in case the combustion proceeds very rapidly and the ammonia is considerably diluted with other gases. The following determinations were made to test the effect of rapid combustion on the absorption of ammonia, and, incidentally, the danger of small particles of soda-lime being swept past the asbestos plug into the acid solution. Although undertaken simply as one of the series of exercises in the undergraduate course of study and practice in this laboratory (Chemical Laboratory of Wesleyan University), the results may not be unworthy of record.

The method followed was that described in a previous article (*Amer. Chem. Journ.*, ix., 319) as usual in this laboratory, except that the packing of the asbestos plug in the anterior end of the tube and the time of combustion were varied, as shown in the tabular statement herewith. The ammonia was caught in an ordinary Knop and Arendt bulb apparatus (with four bulbs) containing 10 c.c. of a rather concentrated standard solution of sulphuric acid, of which 1 c.c. corresponded to about 10 m.grms. of nitrogen. About 0·25 grm. of ammonium sulphate mixed with stearin previously proved to be free from nitrogen, was used for each determination, and furnished ammonia sufficient to neutralise about one-half of the acid.

In the determinations numbered 1, 2, and 3 in the table, the anterior asbestos plug was some 2 to 3 c.m. long and packed reasonably tight, as is usually done in our work. In No. 4 it was shorter than usual, and care was taken to pack it very tightly by holding the tube perpendicular, with the anterior end down, and pressing upward against the asbestos with the flat end of a lead pencil. The soda-lime above furnishes a firm backing, so that the asbestos may be packed as closely as desired. Reversing the tube and tapping it gently, its contents will settle down from the asbestos, leaving a space which can be closed up as much as necessary by pushing the compacted plug toward the soda-lime. In Nos. 5 to 7 the plug was put in loosely, as might be done by a careless operator. The figures in the table for number of bubbles per minute were estimated by countings of the numbers in different minutes, and are of course only approximate. In Nos. 4 and 7 the effort was made to push the combustion as rapidly as could be done without danger of accident. The flow of gas was much more rapid and the bubbles were much larger than would be the case in any ordinary well-conducted analysis. This will readily be seen when we consider that the quantity of diluting gases, from the decomposition of nearly a third of a gramme of stearin in each case, was large, and that the time of the combustion was only twelve minutes, instead of from thirty to sixty minutes which the combustion commonly takes. Add that the quantity of acid solution was rather small, only 10 c.c., and it is evident that the conditions were very unfavourable for complete absorption of the ammonia. The percentages of nitrogen in Nos. 1 to 4 average 21·14. This figure accords very closely with those obtained by other gentlemen who made determinations of nitrogen in the same material and at the same time by the soda-lime and other methods.

Comparison of the figures in the last column of the table shows no loss of nitrogen, even in No. 4, in which the flow of gas was so rapid and the bubbles were so large. To still further test whether ammonia escaped absorption, a second bulb tube with acid solution was connected with the first, so that the gases which came from the first passed through the acid in the second. Even in No. 4 Nessler's test gave no reaction for ammonia in the second tube. It is clear, then, that despite the considerable dilution and extremely rapid flow of the gases through the 10 c.c. of acid solution, no ammonia escaped absorption. But it is to be remembered that the quantity of ammonia was only equivalent to about half of the acid in the solution.*

The large figures of "nitrogen found" in Nos. 5, 6, and 7 are evidently due to the fine particles of soda-lime which were carried through the loosely packed asbestos plugs by the rapidly passing gases. The necessity of proper packing of the asbestos plug is too obvious to need dwelling upon.

The principal fact brought out in these experiments is that the ammonia, the quantity of which was considerable, was completely absorbed by the acid solution in the cases where the combustion was completed in as short a time as twelve minutes, and where the flow of gas was

* See Gassend and Quantin, *Zeitsch. Anal. Chem.*, 1882, 278.

No.	Asbestos plug.	Rapidity of combustion.	Time of combustion. Minutes.	Number of bubbles per minute. Approximate.	Ammonium sulphate used. Grms.	Nitrogen found. Per cent.
1.	Moderately tight.	Rather slowly	60	60	0·2457	21·12
2.	,, ,,	Moderately fast.	35	70	0·2458	21·15
3.	,, ,,	,, ,,	35	70	0·2458	21·15
4.	Short and very tight.	Very ,,	12	90	0·1796	21·16
5.	Loose.	Rather ,,	25	70	0·2630	21·49
6.	Short and loose.	Very ,,	13	85	0·2558	21·69
7.	Long. ,,	,, ,,	12	90	0·2928	21·37

far more rapid than would occur in any ordinary work. The inference is that the absorption of the ammonia is more certain, and the danger of loss less, than is frequently supposed.—*American Chemical Journal*, Vol. x., No. 2.

THE RELATIVE VALUES OF THE WEIGHTS OF HYDROGEN AND OXYGEN.

By JOSIAH PARSONS COOKE and THEODORE WILLIAM RICHARDS.

Introduction.

Since the application by Dalton of the atomic theory to explain the definiteness of the combining proportions of the elementary substancces of chemistry, these proportions have been generally regarded as the ratios of the weights of the atoms, and the values assigned to each element have been generally called atomic weights.

The conception was early suggested and advocated by Dr. Prout, an eminent physician of London during the first half of this century, that the elementary atoms were all aggregates of the atom of hydrogen, the lightest atom known. If this were true, it would of course follow that the atomic weights of the elements would all be multiples of the atomic weight of hydrogen; so that, if the weight of the atom of hydrogen were selected as the unit of the system, all other atomic weights must be multiples of this unit, and therefore whole numbers.

The facts known at the time (1815) were not inconsistent with this view; but as the methods of chemical analysis were improved, and the combining proportions determined with greater accuracy, marked discrepancies from Prout's hypothesis appeared. Still, so great was the hold which the conception had taken upon chemical students, that for a long time the nearest whole numbers to the combining proportions observed were accredited as the true value of the atomic weights, rather than the actual mean of the experimental results; and this practice is still followed in many standard publications, notably the *Jahresbericht über die Fortschritte der Chemie*. In many cases the observed values were so near whole numbers that no important error in the calculation of analyses arose from this practice, the differences neglected being no greater than the uncertainties of analytical method, and this was especially true with regard to the larger atomic weights.

One exception to the theory, however, was so marked that it could not be overlooked, namely, the atomic weight of chlorine, which was capable of being determined with great accuracy; and all the determinations uniformly gave a result which was closely 35·5. This and a few similar cases suggested the idea, that, if the atomic weights were not even multiples of the received hydrogen atom, they might be multiples of the half or quarter hydrogen atom, which would simply amount to taking as the ultimate atom of material things a still smaller unit

The well known chemist, Dumas of Paris, was led by this view to undertake a re-determination of a large number of atomic weights, and many of the results then obtained are still accepted as authoritative.* As was to be expected, Dumas found a much closer agreement with this modified theory than with the original hypothesis of Prout; but obviously such evidence could have but little bearing on the general theory that the atoms were all aggregates of some common unit, for by taking that unit small enough,—even no smaller than the one hundredth of the received hydrogen atom,—all the atomic weights, even those most accurately determined, would be expressed by whole numbers within the limits of probable error.

Soon after, Stas of Brussels, a former assistant of Dumas, endeavoured to set the question of Prout's theory at rest by an investigation which will be ever memorable for its extreme accuracy.* He selected for his investigation those elements whose combining proportions were capable of being determined with the greatest accuracy, and, working on large quantities of material, with every refinement which a full knowledge of analytical methods could suggest, he obtained results which it seemed impossible to reconcile with the theory in any way. This investigation, published in 1865, seemed at first to disprove the theory altogether.

Nevertheless, when Stas's results came to be collated, and as other determinations of similar accuracy came to be published, the fact appeared that a large number of the most accurately determined atomic weights stood to each other in the relation of whole numbers within the limits of accuracy of the most refined experimental work. The number of these cases was so large that it seemed highly improbable that the coincidences should be the result of chance.

This idea was prominently set forth by Professor Mallet, of the University of Virginia, in his admirable paper on the Atomic Weight of Aluminum,† which was a striking illustration in point; and the same feature was also made prominent by Professor F. W. Clarke, of Washington, after a careful review of all the determinations of atomic weights.‡

The coincidences appear more striking if the values of the weights refered to are given in values of the oxygen atom assumed to be 16, as has been done by Professor George F. Becker in his digest of atomic weight determinations.§ The following table from the writer's work on "Chemical Philosophy" will make clear the point in question.

Atomic Weights (most accurately determined).

Hydrogen	1·002	Chlorine	35·46
Lithium	7·01	Potassium	39·14
Carbon	12·00	Calcium	40·00
Nitrogen	14·04	Bromine	79·94
Oxygen	16·00	Silver	107·93
Aluminum	27·02	Antimony	119·92
Sodium	23·05	Iodine	126·85
Magnesium	24·00	Barium	137·14
Phosphorus	31·05	Thallium	204·11
Sulphur	32·07	Lead	206·91

This table includes all the atomic weights which up to 1882 could be regarded as known within one-thousandth of their value, and with one or two notable exceptions there is no instance in which the value differs from a whole number by a quantity greater than the possible error, though not always the "probable error," of the processes employed in their determination.

Were these numbers wholly independent of each other and distributed by no law, we should expect to find every possible intermediate value, and the fact that they so nearly approach whole numbers cannot fail to produce on the mind the impression that there is some influence which tends to bring about this result.

It may be that the discrepancies are due to unknown constant errors, which every experimentalist knows are greatly to be feared. Or it may be that there is in nature a tendency to whole multiples; and this last view, if not compatible with our present conception of the atomic theory, may hereafter appear as one of the phases of a broader philosophy.

The force of evidence which such a distribution of values as the above table presents was brought home to the writer in his investigation of the atomic weight of antimony.|| After eliminating various causes of error, he

* *Annales de Chemie et de Physique*, 3rd ser., lv., 129 (1859).

* *Mémoires de l'Académie Royale de Belgique*, xxxv. Also *Ann. Chem. Pharm.*, Suppl., iv., 168.

† *Phil. Trans.*, 1880, p. 1003.

‡ *Smithson. Misc. Col.*; "Constants of Nature," Part 5, p. 270.

§ *Ibid.*, Part 4.

|| "Additional Experiments on the Atomic Weight of Antimony," *Am. Acad. Proc.*, xvii., p. 13, by Josiah Parsons Cooke.

was enabled to determine with great accuracy the atomic weights of antimony, silver, and bromine, in one and the same series of experiments; and it appeared that this ratio was—

120·00 : 108·00 : 80·00,

with a probable error of less than one in the last decimal place. Here then is a ratio of whole numbers within the one-hundredth of a single unit. Since the ratio of the atomic weights of silver and oxygen have been determined with great accuracy, we can extend the above proportion to a fourth term, the atomic weight of oxygen, which appears also as a whole number, perhaps with a somewhat larger probable error. Still, we have not reached the unit af the system, and when we attempt to extend the ratio to the atomic weight of hydrogen, we find that the most probable value from all experiments hitherto made gives the ratio not of 16 to 1, but of 16 to 1·0025.

If now we wished to refer to the hydrogen unit, the atomic weights of antimony, silver, bromine, and oxygen, whose ratios of whole numbers had been determined as above, it was only necessary to divide all the terms of the above proportion by 1·0031, when we obtain the series of values given below the others, and all semblance to the hypothesis of Prout disappears, although, of course, the second series of numbers bear the same ratios to each other as the first:—

Antimony.	Silver.	Bromine.	Oxygen.	Hydrogen.
120·00	108·00	80·00	16·01	1·0031
119·60	107·66	79·75	15·96	1·00

The numbers in the lower of the two proportions appear as uncommensurable as Stas maintained that they were, and the same is true of most of the atomic weights, when given, as is usual in recent text-books, on the basis of the hydrogen unit.

When, as the result of his investigation on the atomic weight of antimony, there was presented to the writer the ratios of whole numbers as shown in the first of the above proportions, with the single exception of the atomic weight of hydrogen, the question was at once suggested: Is the ratio of the atomic weights of oxygen and hydrogen in fact that of 16 : 1·0025, as the general average of all trustworthy determinations hitherto made seems to indicate, or was there some constant error lurking in these results which caused the very slight variation from 16 to 1 required by the theory? In looking at the proportion thus displayed, it seemed as if the variation from the theory must be apparent, and he determined to ferret out the hidden error if possible. This investigation was undertaken in the autumn of 1883, but owing to the condition of the writer's sight the work has been greatly delayed.

No one can study the record of the investigations by which the ratio of the weights of the oxygen and hydrogen atoms have been determined, without receiving the impression that they are by no means decisive in regard to the theory we are discussing, and it is also equally evident that this ratio, if it could be fixed beyond doubt, would be a crucial test of the theory.

Previous Work.

The methods by which the atomic weights of oxygen and hydrogen have been determined may be divided into two classes: first, the direct method of determining the ratio in which the proportions of oxygen and hydrogen, uniting to form water, were actually weighed; secondly, the confirmatory method, to whose results small weight could be given independent of the first.

Among confirmatory methods we must unquestionably class the classical determinations by Regnault, of the density of oxygen and hydrogen gases under normal conditions at Paris; that is, in so far as these determinations bear on the question of the ratio of the atomic weights.

According to the molecular theory, the ratio of the densities of oxyge and hydrogen gases could only be the ratio of their molecular or of their atomic weights when both materials were in the condition of perfect gases, of which condition the test would be an exact conformity to Mariotte's law. Now, as Regnault himself elegantly demonstrated, oxygen and hydrogen gases at the standard conditions of temperature and pressure, not only do not exactly obey Mariotte's law, but the deviations from the law in these two cases are in the opposite directions, oxygen gas being condensed by increasing pressure more, and hydrogen gas less, than the law requires. Hence theory would not lead us to expect that the ratio of the densities of these gases at the standard conditions would be the exact ratio of their atomic weights. But obviously it may be that this inference from the molecular theory is not legitimate, or it may be that the effect of the imperfect aëriform condition would not perceptibly influence the apparent atomic ratio; and hence the confirmation afforded by Regnault's results is of value.

In the same category we must class also the determination of the atomic weight of oxygen made by Thomsen of Copenhagen, who weighed the amount of water obtained by burning a measured volume of hydrogen gas. Here the reduction of the volume to weight involved a knowledge of values and conditions which could not be known with the greatest accuracy, and unfortunately the details of the experiments have not been published.

Again, we should class simply as confirmatory results deduced indirectly, and involving the values of other atomic weights, however accurately these subsidiary values may be supposed to be known; such, for example, as Stas's determination of the amount of chlorine in ammonic chloride.

Turning now to the actual direct determinations of the combining proportions of oxygen and hydrogen, there are only two which are of any present value. Of these by far the most important is the classical investigation of Dumas, "Researches on the Composition of Water."* This is one of the most memorable investigations in the history of chemistry, and its general principles are known to every student of the science. An indefinite amount of hydrogen was burnt by means of cupric oxide; the amount of oxygen consumed was determined by the loss of weight of the combustion tube, and the amount of water formed was collected and weighed directly. The experiments were on a very large scale, the amount of water produced varying from 15 to 70 grms. The greatest care was taken to insure the purity of the materials used, every known experimental means was employed to secure accuracy, and all necessary corrections were applied to the results. Estimated on the system at present in use, the value of the atomic weight of oxygen obtained by Dumas as the mean of nineteen determinations was 15·9607, with a probable error of ±0·0070, the highest value being 16·024, and the lowest 15·892.

The investigation of Erdmann and Marchand† was far less extended, and some of the precautions taken by Dumas were neglected because deemed unnecessary. No pains seem to have been taken to obtain pure cupric oxide, and the material used in several of the determinations was described as "kaufliche Kupferglühspan," while that used in the others was obtained by igniting cupric nitrate; and no proof is adduced in either case of the purity of the material employed.

The results are divided into two groups, and in the experiments of the second group the air was exhausted from the combustion tube before weighing; but it appears from the paper that the marked difference between the two series of experiments depended rather on the character of the cupric oxide, and on varying conditions used, than on this circumstance. The first series of four results, when averaged, gave the value of 15·937, with a probable error of ±0·0138, while the mean of the second series was 16·009, with a probable error of ±0·0030. The study of

* *Ann. de Chim. et de Physique*, 3rd ser., viii., 189 (1842).
† *Journ. f. Prakt. Chem.*, 1842, vol. xxvi., p. 461.

the paper, however, does not confirm the expectation that the results of the second series are more trustworthy; for the closer agreement and smaller probable error appear to be the result of the identity of conditions, which was maintained in this series, but not in the first. Judging from the paper we should be inclined to place most reliance on the first series, in which the conditions of the experiments were varied, rather than on the second, which seems obviously to be influenced by some constant error.

The results, then, thus far obtained, are as follows:—

Direct Determinations.

Dumas (nineteen determinations) ..	15·9607 ± 0·0070
Erdmann and Marchand (first four) ..	15·9369 ± 0·0138
" " (second four)	16·0095 ± 0·0030

Confirmatory Determinations.

Dumas and Boussingalt* (gas densities)	15·954 ± 0·031
Regnault† (gas densities)	15·961 ± 0·0044
Thomsen‡ (not fully described)	15·960

The one process by which the relative combining proportions of oxygen and hydrogen have been hitherto directly determined is open to serious criticism. In the first place, the circumstance that the weight of the hydrogen is eight times smaller than that of the oxygen, and that this weight has only been estimated by difference, is exceedingly unfavourable to the accuracy of the process. It can easily be seen that, in order to establish a ratio like 1 to 8, the highest accuracy demands that each term of the proportion should be known to an equal degree of exactness. Thus if in a given experiment we have 8 grms. of oxygen uniting with 1 grm. of hydrogen, it is of no avail to weigh the oxygen to the tenth of a m.grm, unless we can weigh the hydrogen to the same proportionate degree of accuracy. For an error of 8-10ths of a m.grm. in the weight of the oxygen, or an error of 9-10ths of a m.grm. in the weight of the water, will have no more influence on the ratio we are seeking than an error of 1-10th of a m.grm. in the weight of the hydrogen. Now, in the process we are discussing the weight of the water can be determined to within a few tenths of a m.grm.; that is, with all the accuracy with which our problem requires that the larger term of the proportion 8 to 1 should be known. It is quite different with the weight of the oxygen. This last is found by weighing the glass combustion tube containing cupric oxide before and after the experiment, and between the two weighings the tube is heated to a low red-heat for several hours while a stream of hydrogen gas is passing through it; and there are several causes which may lead to the variation of these weights, independent of the oxygen which has been used up in the process. We shall allude to some of these causes below, but their effect would be comparatively unimportant if they only led to a small error in the observed weight of the oxygen. Unfortunately their effect is not thus limited; for when, in order to find the weight of the hydrogen, we subtract from the weight of the water, which may be regarded relatively as accurately known, the weight of the oxygen, which may be for the causes referred to slightly erroneous, the whole error appears in the weight of the hydrogen thus found, and in the opposite direction. If, for example, the weight of the oxygen is too large, the weight of the hydrogen will be too small by exactly the same amount; and although the error may be an inconsiderable part of the weight of the oxygen, it may be a very appreciable quantity in the weight of the hydrogen.

On the other hand, if a means could be devised for weighing the hydrogen, leaving the oxygen to be determined by subtracting this smaller weight from the weight of the water, then a small error in the observed weight of the hydrogen would have no appreciable effect on the weight of the oxygen.

Dumas fully recognised the source of error to which we have referred, and in his paper on the subject wrote what may be translated as follows:—

"Of all analyses presented to a chemist, that of water is the one which offers the greatest uncertainty. Indeed 1 part of hydrogen unites with 8 parts of oxygen to form water, and nothing would be more exact than the analysis of water if we could weigh the hydrogen as well as the water which results from its combustion. But the experiment is not possible under this form. We are obliged to weigh the water formed, and the oxygen which was consumed in producing it, and to determine by difference the weight of the hydrogen which has entered into combination. Thus an error of $\frac{1}{900}$ in the weight of the water, or of $\frac{1}{800}$ in the weight of the oxygen, is equivalent to an error of $\frac{1}{80}$ or $\frac{1}{90}$ in the weight of the hydrogen. Let these two errors be in the same direction, and the total error will amount to $\frac{1}{40}$."

In the second place, however carefully the exterior surface of the combustion tube may be guarded, it is impossible that the contents of the tube should bear the same relations to the surrounding atmosphere before and after the combustion. We begin with a tube containing cupric oxide in different states, and we end with it containing reduced copper, whose condition will vary more or less with the character of the oxide employed; and the power of these materials to occlude air or hydrogen is an unknown quantity in our experiment. That it is an appreciable quantity is evident from several incidental observations.

Dumas endeavoured to avoid any source of error arising from this cause by exhausting the combustion tube before weighing it, but he himself expresses a doubt whether a trace of hydrogen might not have been left. Erdmann and Marchand in part of their experiments resorted to the same expedient, but their results obviously vary with the condition of the cupric oxide employed: and the following remarks of Schützenberger, in a discussion of the variability of the law of definite proportions before the Chemical Society of Paris in 1883, as quoted in the *American Journal of Science* (3rd series, vol. xxvi., p. 65), have an important bearing on the same point:—

"When water is synthesized by reduction of a known weight of CuO, by weighing the reduced Cu and the water formed, it is found that the ratio of O to H is not constant, but varies with the state of division and of saturation of the oxide, the duration of contact of the water formed with the oxide, and with the temperature, from 7·95 to 8·15. The latter value is obtained with a saturated and divided oxide filling the tube, the former with oxide in lumps filling the tube for a space of 25 c.m. With a larger empty space the ratio has fallen to 7·90. When the synthesis of water is effected by weighing the hydrogen consumed (as by dissolving a known weight of zinc in HCl) and the water formed, the ratio differs according to the contents of the combustion tubes. If it contains granular CuO of a length of 80 c.m. heated to redness, the ratio O : H is 7·96 to 7·98 to 1; at a low temperature, 7·90 to 7·93; if the CuO is replaced by $PbCrO_4$, from 7·89 to 7·93."

In addition to all this, impurities in the oxide of copper might have a serious influence on the result. As before said, Erdmann and Marchand speak of using "kaufliche Kupferglühspan"; but in our work we could find no commercial cupric oxide which did not contain a marked amount of arsenic. We examined a number of specimens coming from the best German and American dealers, and there was not a single instance in which we did not find arsenic, and even when the material was marked "purissimum." In some cases the amount of arsenic was so great that, after successive reductions and oxidations, abundant crystals of arsenious oxide collected at the exit end of the combustion tube. It is unnecessary to add that the hydrogen used was free from all such impurity.

* *Compt. Rend.*, xii., 1005; also "Constants of Nature," Part V., p. 6.

† *Compt. Rend.*, xx., 975; also "Constants of Nature," Part V., p. 6.

‡ *Berichte der Deutsch. Chem. Gesell.*, 1870, p. 928; also "Constants of Nature," Part V., p. 8.

For our own experiments, of which the results are given below, not only was the oxide of copper prepared from absolutely pure electrolytic copper, but also, as will be shown, the combustion tube was left at the end of the determination as it was at first, and the same tube was used for a number of experiments.

(To be continued).

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

June 23rd, 1888.

Professor Reinold, F.R.S., President, in the Chair.

The following communications were read:—

"*The Photometry of Colour.*" By Capt. Abney, R.E., F.R.S.

This relates to the measurement of light reflected from coloured surfaces and pigments as compared with the quantity reflected from white or black. The apparatus used in the investigation consisted of a spectroscope and camera similar to those used by the author for the production of a patch of monochromatic light, and a small shadow photometer served for the measurement. The screen was made of two parts, one the colour to be tested, and the other white or black, according to the standard being used, and the stick was arranged so that the shadows fell near the junction of the two parts. Light reflected from the surface of the first glass prism served to illuminate one shadow, and for the other monochromatic light of any desired colour could be used. The intensities were adjusted to equality by cutting off more or less of the stronger light by means of a revolving wheel with adjustable sectors, the opening of the sectors being a measure of the luminosity of the pigment.

In another arrangement a double-image prism was used to separate the spectrum into two parts. Monochromatic light from one part passed direct to the screen through sectors in a rotating wheel, and monochromatic light from the other spectrum was reflected on the screen at a sufficient azimuth to give a separate shadow by means of two total reflection prisms. The losses by reflection were allowed for by observing the position of the adjustable sectors required to give equal intensities on a white screen. From the results obtained "colour curves" can be plotted for different pigments, &c., and templates constructed which—when rotated in the path of a spectrum—reproduce the corresponding colour. Carmine, sky-blue, and gold were thus reproduced. By means of templates constructed from "colour curves" any colour may be reproduced at any future time. In course of the experiments many interesting observations on colour-blindness have been obtained by the author and General Festing, some of which were described.

A question was asked as to whether it was possible to reproduce any given colour, for no two arc lights could be expected to give exactly equal intensities in all parts of the spectrum.

Dr. Thompson requested information regarding the effect of absorption by the different thicknesses of the prism through which the light passed, and thought the results obtained might be different if prisms of other material were used. The fact mentioned in the paper as to the sky being greenish is well known to artists, who usually mix cobalt blue with yellow to produce the required tint. Dr. Thompson also reminded the members of an experiment he brought before the Society some years ago, in which grass seen through a solution of permanganate of potash appears bright crimson, when compared with red colours seen through the same solution.

In reply, Captain Abney said that colours could be imitated whatever the source used to produce the spectrum, for the resulting colour is the same as that seen when the "original" is viewed by light from that source. Regarding absorption, &c., by the prism, he did not think any appreciable difference was produced, for the results obtained when using the re-composed spectrum as white light were the same as those got by using light reflected from the surface of the first prism. In conclusion he directed the attention of physicists to Lord Rayleigh's paper on Sky Colours, &c., published in the *Phil. Mag.*, which would well repay very careful study.

"*Note on Continuous Current Transformers.*" By Prof. S. P. Thompson, D.Sc.

Two classes of transformers are considered, viz., *motor-generators* and *commuting transformers*, in which a two-circuit armature is fixed in a revolving magnetic field. Such a field may be produced by using a fixed gramme ring as the field magnet and rotating the brushes round its commutator. The formulæ obtained apply equally to both classes.

If C_1, C_2 be the numbers of primary and secondary wires on outside of armature, E_1, E_2; e_1, e_2; i_1, i_2; r_1, r_2; the E.M.F., potential differences at terminals, currents, and resistances of primary and secondary respectively, then it is shown that $e_2 = k\, e_1 - (r_2 + k^2\, r_1)\, i_2$, where—

$$k = \frac{C_2}{C_1},$$

which is called the "coefficient of transformation." Thus, the potential difference is the same as if the dynamo part had its resistance increased by $k^2\, r_1$. As the currents in the primary and secondary are in opposite directions the effective self-induction will be very small; hence such machines can be run with little or no sparking.

In a previous paper, by the same author, similar properties, as regards self-induction and resistance, were shown to exist in alternating current transformers. From the above equation it is evident that a motor-generator cannot be made to give constant potential when supplied at constant potential, except when the internal resistances are very small: but by over-compounding the distributing dynamo the desired result may be obtained.

Mr. Kapp agreed with the author as regards motor-generators running with little sparking, but thought the great difficulty in using them commercially would be in preserving the insulation between the circuits if anything like 2000 volts were used in the primary. He also mentioned the methods of producing a rotating field by alternating currents, recently described by Prof. Ferraris and Mr. Tesla, and thought it would be preferable to the one devised by the author of the paper.

In reply, Dr. Thompson said that insulation could be easily maintained between the core and windings of brush armatures, and saw no reason why it should present very serious difficulties in continuous current transformers.

"*On an Optical Model.*" By Prof. A. W. Rücker, F.R.S.

The model exhibited and described is to illustrate the character of the vibrations in a crystal cut parallel to the axis, when plane polarised light is incident upon it. A rectangular glass box represents the crystal, and glass plates placed at short distances from each end imitate crossed Nicols. A rod, carrying coloured circular and elliptical rings, and straight bars, passes along the axis of the box. These rings are intended to indicate the character of the vibration at the different points at which they are placed. The length of the crystal is supposed to be such that plane polarised red rays emerge plane polarised in the initial plane after being successively plane, elliptical, circular, elliptical plane, elliptical circular, elliptical and plane polarised within the crystal. All the light is quenched by the analysing Nicol. Supposing light of greater frequency (say green) to be used, another rod with green ellipses, &c., is placed in the box, and illustrates

that such light emerges elliptically polarised, one component only of which is stopped by the analysis. This shows how plane polarised white light, when passed through crystals placed between Nicols, may become coloured.

"*On a New Barometer.*" By Mr. T. H. Blakesley, M.A.

A uniform glass tube is sealed at one end, and a thread of mercury introduced, enclosing a quantity of air. An observation is taken by noting the volumes, A and B, of the enclosed air (as indicated by the divisions on the scale), when the tube is placed vertically with its closed and open ends upward respectively. The height, H, of the barometer is given by the formula—

$$H = \frac{A+B}{A-B} l,$$

where l is the length of the mercury column in the tube. For convenience l is made 10 inches. The whole instrument is very portable, weighing only 6 ozs., and measuring about 18 inches long.

In the absence of the author a paper "*On the Existence of an Undulatory Movement accompanying the Electric Spark,*" by Ernest H. Cook, D.Sc., was taken as read.

When sparks pass between two points placed above a plate on which some powdered substance has been scattered, the particles arrange themselves in circular lines approximately concentric with the projection of the middle line joining the two points. The proximity of the lines is found to be very nearly constant for the same powder, independent of the intensity of the spark used or the material of the plate. Different powders give different numbers of lines per inch, and mixtures numbers between those corresponding to their constituents. A great number of substances have been tried, giving numbers between 40 and 88 per inch. These extreme numbers were obtained for chalk and silica respectively. The author has found no satisfactory hypothesis by which to explain the results. A number of photographs accompany the paper, showing the character of the figures produced.

At the meeting an apparatus made by the late Dr. Guthrie was exhibited, with which similar figures to those described in the paper could be obtained. It consists of a shallow elliptical dish, covered by a glass plate. Sparks are passed between two small knobs across one focus, and powder sprinkled on the bottom forms into circles about the other focus.

CORRESPONDENCE.

FRENCH TECHNICAL TERMS.

To the Editor of the Chemical News.

Sir,—Allow me to thank your correspondent, Mr. Bruce Warren, for his reply to my query. As I am far removed from a "good library" I should feel greatly obliged if Mr. Warren or anybody else would explain the meaning of these figures in the analyses of sugar beets:—

	I.	II.
Pureté vivien	85·200	85·240

In the analyses the "density," "sugar," "salts per hectare of juice," "saline coefficient," are all given.

Does "*pureté vivien*" mean in this case "*the quotient of purity*" (Chemical News, xlv., p. 191; *Journ. Chem. Soc.* [Abstracts], 1882, p. 899; *American Chemist*, 1873)? Concerning the word *démariage* here is the sentence containing it:—

"L'épandage du sulfate de manganèse doit se faire seulement après le démariage, le sel doit être en poudre et mélangé avec 5 ou 10 fois son poids de terre ou de sable pour assurer une répartition régulière."

To conclude, I should feel greatly obliged to any correspondent for answering the above.—I am, &c.,

Chemicus.

ANALYSIS OF FERRO-ALUMINIUM.

To the Editor of the Chemical News.

Sir,—Will you allow me to answer the question propounded by "Engineer" (Chemical News, vol. lvii., p. 249) respecting the analysis of ferro-aluminium?

I have analysed several hundred specimens, and find no difficulty in ascertaining the percentage of Al with a fair degree of accuracy.

There is no difficulty in applying the separation by sodium hydrate to this alloy, except the difficulties inherent in the method itself,—it is very apt to give too low results.

I prefer myself to use the indirect method of weighing the combined oxides of Fe and Al precipitated in the ordinary manner by NH_4OH, and subtracting the weight of Fe_2O_3 found by titrating an aliquot part of the same solution with potas. bichromate solution.

The solution of the alloy is easily effected by nitro-hydrochloric acid, and the silica separated in the usual manner.

I have applied this method to all the grades of ferro-aluminium that we manufacture, varying from 1 to 19 per cent Al, but for estimating fractions of 1 per cent contained in steel the thio-sulphate method, described on page 212 of "Select Methods in Chemical Analysis," by Mr. Crookes, is more accurate.—I am, &c.,

H. N. Yates.

The Cowles Syndicate Company,
Milton, Stoke-on-Trent, June 29, 1888.

Action of Crystalline Formic Acid upon the Terebenthenes.—J. Lafont.—Formic acid yields with French oil of turpentine different products according to the manner in which the operation is conducted. At 100° almost the sole product obtained is diterpilene, a carbide, the polymer of terpilene, without rotatory power. In the cold and on moderating the reaction there is obtained terpilene formiate in abundance, along with a small quantity of the formic ethers of terpine and of borneol, and a small proportion of a diterpilene possessing a lævo-rotatory power. In the first fractions there is also obtained oil of turpentine scarcely modified and terpilene not combined with formic acid. Dextro-rotatory American oil of turpentine yielded identical products, except as regards the rotatory power.—*Bulletin de la Société Chimique de Paris*, Vol. xlix., No. 5.

Researches on the Falsifications of Butter.—P. Bockairy.—The author, in continuing his researches, has been led to adopt toluene instead of benzene. He places in the test-tube 15 c.c. of pure toluene, adds 15 c.c. of the fatty substance melted and filtered, and pours in 40 c.c. of alcohol at 96·7°. At 18° the toluene, holding in solution the fatty matter, remains at the bottom of the tube, whilst the alcohol occupies the upper portion. The test-tube is then heated to 50° by immersion in a water-bath of that temperature, and shaken up so as to mix the two liquids. If the sample is a fat there immediately occurs turbidity, but if it is butter, even if mixed with fat, the two liquids mingle without turbidity. To know if the butter is pure, it is sufficient to place the test-tube, after shaking it well, in water at 40°, and to keep it for half an hour at this temperature. If the butter is pure there is no turbidity, but if it contains a foreign fat there appears at once a turbidity, and ultimately a precipitate.—*Bulletin de la Société Chimique de Paris*, Vol. xlix., No. 5.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of emperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 25, June 18, 1888.

The Fluorescence of Ferriferous Lime.—Lecoq de Boisbaudran.—The author's experiments seem to show that iron, with an excess of lime, produces a green fluorescence, independent of the presence of copper in the salt of iron employed.

On Electrolysis by the Alternating Currents of Dynamo-machines.—G. Maneuvrier and J. Chappuis. It is commonly supposed that the alternating currents furnished by dynamos are as incapable of decomposing the acidulated water of a voltmeter as of deflecting the magnetic needle. But this incapacity is only apparent, for if we substitute, in the same voltmeter, very fine wires for the broad electrodes, the same alternating currents produce immediately an abundant escape of gas.

Combination-heat of the Primary, Secondary, and Tertiary Aromatic Monamines with Acids.—Leo Vignon.—The substitution of methyl-radicles for hydrogen in ammonia, and in the group NH_2 of aniline, weakens the basic function but little, but that of the radicle C_6H_5 enfeebles it in very considerable proportions.

On Cuprous Chloride Hydrochlorate.—Paul Sabatier.—The author has obtained this compound in crystalline needles of a hyacinth-red colour, to which he assigns the formula $CuCl,HCl,5HO$.

The Decomposition of Barium Ferrate at High Temperatures.—G. Rousseau and J. Bernheim.—Barium ferrate is decomposed under the influence of heat in two very different manners. If heated in a neutral flux it is at once decomposed into ferric oxide, oxygen, and barium oxide. In presence of a large excess of baryta in the flux the ferrate is split up progressively into free oxygen and crystalline barium ferrite.

Certain New Double Phosphates in the Magnesian Series.—L. Ouvrard.—All the metals considered (magnesium, zinc, cadmium, manganese, cobalt, and nickel) approximate in the composition of the products which they yield with potassium and sodium pyro- and ortho-phosphates. The metaphosphates alone give marked differences, which sever these six metals into three groups. Manganese and magnesium are further distinguished by their property of yielding chlorophosphates.

Certain Compounds of Mannite.—J. Meunier.—The author studies the mannitoids, compounds of the anhydrides of mannite with the aldehyds and probably with closely allied bodies. These compounds differ from the ethers in not being saponifiable, even by alcoholic potassa. They are distinguished from the acetals, bodies which are rapidly decomposed when boiled with an aqueous alkaline solution.

The Aspartic Acids.—M. Engel.—The fixation of the elements of ammonia upon the maleic and fumaric acids gives one and the same aspartic acid, which is optically inactive and capable of being split up.

Bulletin de la Société Chimique de Paris. Vol. xlix., No. 2.

Detection and Determination of Aldehyds in the Alcohols of Commerce.—U. Gayon.—Previously noticed.

Action of Chlorine upon Sulphonic Compounds and Heptylic Oxysulphides.—W. Spring and C. Winssinger.—The authors conclude that the laws to which the action of chlorine upon sulphonic compounds appears to be submitted, seem to find a satisfactory explanation neither in the theory of Kekulé nor in that of Kolbe. Organic molecules cannot be assimilated to simple mechanical systems, nor to organisms, properly so-called. We fall into error in reasoning upon these theories, not that they are completely false, but that they give us only an imperfect picture of the reactions.

On Diazo-amidic Derivatives.—E. Noelting and F. Binder.—This extensive memoir cannot be usefully abridged.

Action of Oxalic Acid upon Cinchonine in Presence of Sulphuric Acid.—E. Caventon and Ch. Girard.—By this reaction new bases are formed which are separated by treating the crude product with a large volume of water, precipitating with ammonia, collecting and drying the precipitates, and treating them with ether, in which a part only is soluble. The mass insoluble in ether is chiefly cinchonine not attacked during the operation. The ethereal solution is agitated with water acidulated with hydrochloric acid, which seizes the bases. The aqueous portion is separated, precipitated with ammonia, and the precipitate, previously drained, is treated with benzene. There exist two bases, the one soluble in ether and benzene, the other soluble in ether but insoluble in benzene.

On Syntheses in the Quinoleic Series by Means of Acetyl-acetone and its Derivatives.—Alph. Combes.—From the author's researches there results a general method for the preparation of the methyl-quinoleines. They may all be obtained at will by varying the acetyl-acetonic derivative and the amine employed.

On the Nitro-camphorates or Saline Combinations of Nitro-camphor.—P. Cazeneuve.—This acid forms definite and generally crystalline compounds with the metals and the alkaloids. The author describes here the nitro-camphorates of sodium, potassium, ammonium, calcium, barium, zinc, iron (ferrous), silver, copper, and lead, and, among the alkaloidal compounds, quinine nitro-camphorate. It is remarkable that though quinine and nitro-camphoric acid are both lævo-rotatory, their combination is dextro-rotatory.

Synthetic Researches on Certain Derivatives of Diphenyl.—P. Adam.—A continuation of the study commenced in vol. xlvii., p. 686.

No. 3.

Products of the Alcoholic Fermentation.—Ed. Claudon and E. C. Morin.—The fermentation of a saccharine matter by pure elliptical ferment yields, besides ethylic alcohol, aldehyd, normal propylic, isobutylic, and amylic alcohols, acetic and succinic acids, isobutylenic glycol, glycerin, furfurol, bases, and a quantity of an ill-defined product, œnanthic ether. It can, therefore, not be said that the elliptical ferment yields pure ethylic alcohol.

No. 4.

Preparation of Methyl-acetyl-cyanacetate.—Alb. Haller and Alfred Held.—Previously noticed.

Researches on the Falsifications of Butter.—P. Bockairy.—The author melts the fatty matters to separate the water, decants upon a filter to remove impurities, and pours 10 c.c. of the fatty matter kept dissolved on the water-bath into 20 c.c. of crystallisable benzene, adding then alcohol at 96·7° Gay Lussac, until a turbidity appears in the test-tube at the temperature of 18°. When the turbidity is very distinct the test-tube is immersed in water at 12°. After the lapse of an hour the precipitate is formed and does not increase perceptibly. The test-tube is then taken out of the liquid and we note the number of c.c. of the lower stratum, observing also if this stratum is liquid, if it contains flocks of fatty matter, or if it is entirely flocculent. A pure butter never deposits more than 10 c.c. of the lower liquid stratum, and there

are always, at the bottom and on the sides of the lower stratum, a few flocks. A butter which immediately deposits at 18° on the addition of at least 35 c.c. of alcohol, and yields a lower stratum at 12° of more than 10 c.c. is at once to be regarded as suspicious.

On a Carbohydrate capable of Fermentation.—E. Grimaux.—It results from the author's researches that oxidised glycerin yields glyceric aldehyd capable of alcoholic fermentation. This is the first time that a fermentible sugar, possessing the same reactions as the glucoses, has been obtained synthetically. The definition of fermentible sugars should be modified, as they are not necessarily carbohydrates containing C_6 or C_{12}, since their characteristic properties appear also in glyceric aldehyd, $C_3H_6O_3$.

MISCELLANEOUS.

Technical Instruction.—There will be a Conference on Technical Instruction at the Technical College, Leonard Street (Tabernacle Row), City Road, E.C., on Wednesday, July 11th, 1888, at 8 p.m. Chairman, Sir Albert K. Rollit, M.P. This Conference is the last of a series of Conferences which have been held during the present Session. At the former Conferences Technical Education was discussed mainly in relation to the training of artisans in the different trades. At this Conference, which will be an open one, not restricted to any particular trade or group of trades, discussion will be invited upon the proposals for Technical Instruction now before Parliament.

The Stevens Institute of Technology.—One of the most satisfactory features which the United States of America present to the enlightened observer is the extent to which facilities for scientific and technical education and research are due to private munificence. Instances of this patriotic liberality will doubtless be familiar to our readers, but we feel it our duty to make special mention of the gifts of Professor Henry Morton to the Stevens Institute of Technology, of which he has been for some time the President. He had previously founded a Chair of Applied Electricity and a Mechanical Workshop. His next gift was the foundation of the Morton Scholarship, and he has now handed over to the trustees of the Institute the sum of 10,000 dollars as a first instalment towards the endowment of a Chair of Engineering practice. We notice with pleasure the happy expression used by Mr. Dod in announcing this gift to the students and their friends. Said the speaker, "greater than all these, he has given himself to the Institute. The Institute is what it is because Henry Morton is its President." Beyond all doubt other public-spirited men will come forward to complete what Professor Morton has so well begun. Let us also express the hope that he may find more imitators on this side of the Atlantic. Notwithstanding, *e.g.*, the foundation of the Owens and the Mason Colleges and the Cavendish Laboratory, there is still no little room left for wealthy men to exercise their munificence in a manner so honourable to their own memories and so beneficial to their country.

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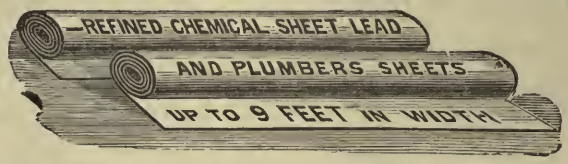

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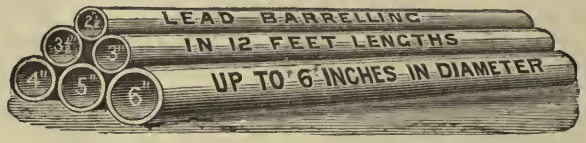

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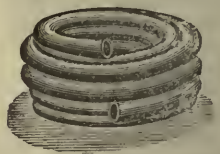

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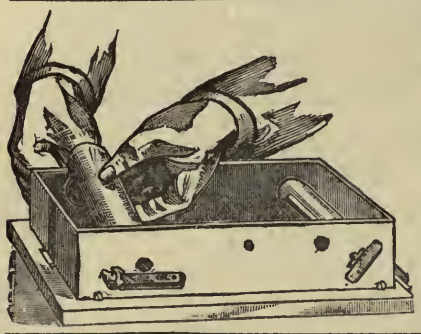

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THE CHEMICAL NEWS.

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ON THE CHANGE OF POTENTIAL OF A VOLTAIC COUPLE BY VARIATION OF STRENGTH OF ITS LIQUID.*

By Dr. G. GORE, F.R.S.

This paper contains a series of tables of measurements of the electromotive forces of a voltaic couple composed of unamalgamated zinc and platinum in distilled water, and in aqueous solutions of different strengths of the following substances:—Potassic chlorate, potassic chloride, hydrochloric acid, and bromine. The measurements were made by balancing the potential of the couple by that of a suitable thermo-electric pile (*Birming. Phil. Soc. Proc.*, vol. iv., p. 130) through an ordinary astatic galvanometer of about 100 ohms resistance.

The following are the minimum proportions of those substances required to change the potential of the couple in water:—Potassic chlorate, between 1 in 221 and 258 parts of water; potassic chloride, between 1 in 695,067 and 1,390,134; hydrochloric acid, between 1 in 9,300,000 and 9,388,185; and of bromine, between 1 in 77,500,000 and 84,545,000 parts.

With each of these substances a gradual and uniform increase of strength of the solutions, from the weakest up to a saturated one, was attended by a more or less irregular change of electromotive force.

By plotting the quantities of dissolved substance as ordinates to the electromotive forces as abscissæ, each substance yielded a different curve of variation of electromotive force by uniformly increasing the strength of its solution, and the curve was characteristic of the substance. As the least addition of a foreign soluble substance greatly changed the "minimum point," and altered the curve of variation of potential, both the curve and the minimum proportion of a substance required to upset the balance of the couple in water, may probably be used as tests of the chemical composition of the substance, and as means of examining its state of combination when dissolved: by varying the strength of the solution at each of the metals separately, a curve of change of potential was obtained for each positive metal, but not for every negative one.

ON A NEW METHOD OF EXAMINING MIXTURES OF OILS.

By THOMAS T. P. BRUCE WARREN.

Lard oil is so frequently met with in samples of olive oil that I have slightly modified the procedure for its separation (see Chemical News, vol. lviii., p. 4).

As poppy oil is almost invariably present in this mixture, the quantity of lard oil removed from the coagulum by CS_2 would not account satisfactorily for the low iodine absorption, considering the quantity of poppy oil which apparently was present. The presence of poppy oil is easily confirmed by passing ozone into the mixture for a short time, when a black product will be obtained by SCl_2, and the viscosity will be considerably increased.

The lard oil is imprisoned in the altered oils and is difficult to remove entirely, but by boiling the coagulum in a moderately strong alkaline solution, almost the whole of the lard oil is removed; the remaining mass is well washed with water, dried, and any adhering non-saponifiable oil removed by means of ether. If too strong an alkaline solution be used, it will partly decompose the altered oils, which will then be removed with the adherent lard oil when treated with ether.

The dried mass is first weighed and placed in a filter-tube plugged with asbestos, ether is poured on, and the oily solution received in a tared flask; the residuum, after evaporation of the ether, is deducted from the weight of the mass. If the coagulum is first treated with CS_2, it is necessary to remove all traces of it before boiling with alkali.

Knowing the iodine absorption of the mixture and the proportion of this absorption due to the recovered lard oil, we have the difference corresponding to the olive and poppy oils. If we know that two oils only are present, and we know the iodine absorption of each, we have no difficulty in fixing on the quantities of each necessary to give the required iodine absorption.

The only uncertainty likely to arise is caused by the variation in poppy-seed oil from oxidation; when oxidised by age or exposure its iodine absorption will fall from 135 per cent to 90 per cent. If we can feel sure of oxidising the oil so as to obtain the minimum absorption, we could increase the certainty of the analytical result.

A SEAWEED DYE.

By F. NETTLEFOLD, F.C.S.

While experimenting on the production of gelatinous gun-cotton it occurred to the experimenter to nitrate alginic acid. This formed a low nitrated body, which was not analysed; it was sufficiently elastic on compression, but not explosive. When dissolved in water in alkaline solution it gave a brown colour. The original colour of the nitro-alginic acid was bright yellow and insoluble in water.

Unmordanted cotton dyed a fine Bismarck brown colour, which was fast to soap, more than many aniline colours, equalling chrysoidine. Mordanting with alumina or tartar emetic did not increase the fastness or the depth of the colour. The depth of shade was considerable, and could be worked to a great intensity. In an acid solution the dye failed to attach itself to the fibre, ammonia being the best alkali.

For wool the brown dye appeared to have little power of attraction. Mordanting did not increase the depth of the dye.

PHENOL AND SOME ALLIED BODIES AS TESTS WITH CONCENTRATED SULPHURIC ACID FOR NITRITES, NITRATES, AND CHLORATES IN AQUEOUS SOLUTION.

By DAVID LINDO.

(Continued from p. 3).

Sulphurous Acid.—(Solution about 4 per cent).

Nitrites.—On adding 2 drops of the SO_2 solution to 0·5 c.c. 2000 N_2O_3, then one drop of phenol and 2 c.c. sulphuric acid, not the slightest trace of colour was obtained. With orcinol the result was much the same, even when HCl was introduced and the tests allowed to stand several hours. In a few instances there was slight diffused darkening of the tests, but no definite colour or band. If an alkaline sulphite was used instead of SO_2 solution, on running in the sulphuric slight bands appeared, showing the N_2O_3 had not been completely destroyed.

Nitrates.—Two drops SO_2 had no perceptible influence

* Abstract of a Paper read before the Royal Society, June 14th, 1888.

at high or low dilution of N_2O_5 with phenol or orcinol, and whether HCl was added or not. The tests could not be distinguished from comparative ones of the same dilution, but containing no SO_2, made alongside. 2 c.c. 5000 N_2O_5, diluted with 8 c.c. of the SO_2 solution, tested against 2 c.c. 5000 N_2O_5 diluted with 8 c.c. water, 0·5 c.c. for each test, and HCl to develop, gave similar bands with the reagents, after standing about an hour. Experiments made with free nitric acid instead of nitrate seemed clearly to show the SO_2 had no influence under the conditions of the experiment.

Chlorates.—Two drops of SO_2 lowered intensity of the bands considerably, yet faint reaction was obtained at 50,000 Cl_2O_5. A distinct rainbow band was obtained at 10,000, but much paler than when SO_2 was absent. The sulphuric was run in immediately after adding the SO_2; when HCl was used the bands were still weaker.

The influence of some other bodies has been studied, but it is not pretended that the research has in this direction been anything like exhaustive; salts of ammonia, phosphoric, and boric acids, seem to have no appreciable influence on the delicacy of the reactions. The detection of *nitrates* in presence of iron and copper salts has been pretty closely studied, a summary of the results being given further on. In these experiments, as well as others on the detection of nitrites, nitrates, and chlorates in presence of each other, sulphurous acid has often to be employed. The SO_2 *must be added before anything else* to the solution to be tested, the phenol or orcinol *last*, before running in the sulphuric.

To avoid repetition I will state here once for all that half a c.c. of the pure solutions of nitrite, nitrate, or chlorate or mixtures of these, is the quantity that has always been taken for each test; the same when iron or copper solution has been mixed with an equal volume of nitrate; when a drop of metallic solution was used this was added to 0·5 c.c. of the solution to be tested.

Salts of Iron.

The influence of these on the detection of nitrates has been chiefly studied, but I may here state that the presence of iron in large quantity interferes with the detection of chlorates by orcinol.

Solution of Ferric Chloride.

Dissolved pure iron wire in pure HCl, added potassic chloride in the heat, evaporated to dryness on water-bath; dissolved in water with addition of a few drops HCl. 5 c c. gave 0·009 grm. of ferric oxide.

The presence of a considerable quantity of ferric iron does not interfere with the detection of nitrates by phenol. 50,000 N_2O_5, mixed with equal volume of the iron solution gave very good bands after standing the usual time. As the iron solution contained sufficient chlorides to develop the bands, HCl was not added. Experiments with stronger solutions of nitrate mixed with equal volume of iron solution gave, as might be expected, still more satisfactory results.

Orcinol is not quite as good a reagent as phenol for the detection of nitrates in presence of much ferric iron. 10,000 N_2O_5, mixed with equal volume of iron solution, HCl added, gave as strong but not as brilliant bands as when ferric iron was absent. On repeating the tests, however, with addition of 2 drops SO_2, thus converting the ferric into ferrous iron, the bands obtained were quite as strong and brilliant as 20,000 N_2O_5 gave without iron tested alongside; SO_2 should therefore be used in testing for nitrates with *orcinol*, solutions containing much iron in the ferric state.

Solution of Ferrous Sulphate.

A fresh aqueous solution containing 1 grm. of the salt in 10 c.c. was employed.

Phenol is not available for the detection of nitrates in presence of much ferrous iron. 10,000 N_2O_5 gave no reaction with 1 drop iron solution and HCl; at 5000 N_2O_5 reaction was very indistinct; using more reagent did no good.

Orcinol, on the contrary, will detect nitrates in the presence of a very large excess of ferrous iron. 50,000 N_2O_5, with 1 drop iron, HCl, and 2 drops orcinol, gave orange band at once, almost if not quite as strong as without iron. 10,000 N_2O_5 with equal volume of iron solution gave excellent bands with HCl and the usual quantity (2 drops) of orcinol. When 3 drops of reagent were employed the bands were still better. In presence however, of this enormous excess of ferrous iron, the bands, after getting a little stronger, decline and become much weaker. If the tests are left in the open tubes some hours longer the bands, as usual, become diffused, but gradually acquire a deeper orange colour.

Copper.

A solution of sulphate was prepared from electrotype copper and pure sulphuric acid. Strength of solution, 0·5 grm. metal in 100 c.c.; it contained a slight excess of sulphuric acid.

The presence of a considerable quantity of copper does not interfere with the detection of nitrates by phenol. At high dilutions of N_2O_5 one drop of the copper solution rather improved the reaction than otherwise. When 10,000 N_2O_5 was mixed with equal volume of copper solution the phenol bands were stronger than 20,000 N_2O_5 gave without copper, but the reds not so brilliant; a lower olive-coloured band was observed. HCl, of course, was always added.

The copper solution increases the delicacy of orcinol as a test for either nitrites or nitrates to a remarkable extent, but HCl must be present, and in sufficient quantity, even with nitrites, or the bands (at high dilutions) will be purple, instead of pink, orange-pink, or a pronounced orange. One drop HCl *b* was found not too much in testing for nitrites with orcinol and copper, and quite sufficient in testing for nitrates. 1,000,000 N_2O_3 with HCl, 1 drop copper, and 2 drops orcinol gave in ten minutes sharp orange-pink bands, which in half an hour were broader and distinct. 200,000 N_2O_3 with the same reagents gave bands decidedly better than 100,000 N_2O_3 and very little inferior to 50,000 N_2O_3 tested with orcinol and sulphuric acid only; the difference is quite as great with nitrates. 500,000 N_2O_5 with HCl, 1 drop copper, and 2 drops orcinol gave distinct sharp bands in five minutes. Without copper the bands are developed very slowly at this dilution, and at their best are very weak.

In presence of much ferrous iron the copper appears at first to have no effect, but if the tests are allowed to stand several hours its influence becomes very apparent.

The presence of iodides or bromides would prevent the detection of nitrites, nitrates, or chlorates by this method of analysis; therefore, if present, it will be necessary to precipitate with silver sulphate. This will sometimes have to be done when the solution to be tested contains hydrochloric acid or chlorides, since, as will be presently apparent, these would interfere with the detection of nitrites and chlorates in the presence of nitrates. The detection of the latter, however, would not be interfered with unless HCl or chlorides were present in *enormous* excess.

If, in the presence of *sulphurous acid* and absence of organic matter* a distinct pink or red band is obtained with phenol, and a pink, orange-pink, or pronounced orange with orcinol, after the addition of sulphuric acid. This proves nitric acid was present; proves it, so far as I have been able to ascertain, beyond the shadow of a doubt. We may therefore dispense with the additional evidence which greater development of the bands by HCl would afford, and which, of course, would not be available if the original solution contained sufficient HCl or chlorides unless these were first removed.

* Also, of course, in the absence of any body, that would give a colour with sulphuric or sulphuric and SO_2 without other reagents.

Detection of Nitrites, Nitrates, and Chlorates in the presence of each other.

A fresh solution of SO_2, about 5 per cent, was used from here. In applying the methods here described it is necessary to bear in mind that, if the solution to be tested has an alkaline reaction, one or two drops of dilute sulphuric acid should be added (unless HCl is used) after the SO_2, otherwise N_2O_3, if present, may be very incompletely destroyed. The point of the pipette from which the solution is delivered should rest on the bottom of the test-tube, *not on the side*, to avoid as much as possible soiling the latter with the solution. The solutions must not be too strong, or the reactions will be indefinite from the characteristic coloured nitro-compounds being mixed with oxidation-products, or, in the case of chlorates, from over oxidation of the orcinol.

It has been shown thut when nitrous acid is liberated in the presence of sulphurous in excess, the former is so completely destroyed that no band can be obtained with either phenol or orcinol, even with the addition of HCl. However, on repeating the experiment previously recorded with the addition of copper solution, a faint pink band was observed after two or three hours. 2000 N_2O_3 mixed with equal volume of sulphurous acid solution gave the same result when 0·5 was treated with 1 drop HCl, 1 drop copper solution, and 2 drops of orcinol, and the same occurred when 0·5 c.c. 8000 N_2O_3 was treated with 2 drops SO_2 and other reagents as above. The band was no stronger when 2000 N_2O_3 was tested in the same way. There can be no doubt the presence of a trace of nitric acid is here indicated, but whether existing as impurity in the nitrite or formed by conversion of a minute quantity of nitrous acid—notwithstanding the excess of SO_2 present—it is impossible to decide with certainty. I may state the silver nitrite was prepared with great care, having been crystallised three times from hot water, pressed, and washed each time in a Gooch crucible—using no filtering medium but the perforations—and dried over sulphuric acid in the dark.

Assuming that a minute quantity of N_2O_3 is converted into N_2O_5 under the conditions of the experiment, this will not, however, interfere with the certain detection, within very wide limits, of nitrate in the presence of nitrite by the method here proposed.

Nitrite and Nitrate.

The detection of nitrite and nitrate when the latter preponderates will generally be found a very simple matter. One example may suffice. Mixed equal volumes of 10,000 N_2O_5 and 100,000 N_2O_3. This mixture reacted with either phenol or orcinol. Tested again, with addition of two drops SO_2, no band, or practically none. Nitrite destroyed, nitrate latent. Tested again, with addition of SO_2 and HCl, red band with phenol, orange with orcinol. Nitrite destroyed, bands due to nitrate developed by HCl.

The following mixtures were tested for nitrate only. As the nitrite could certainly be detected in any of them it was unnecessary to demonstrate its presence. Equal volumes of 10,000 N_2O_5 and 10,000 N_2O_3; the nitrate could be detected by either phenol or orcinol. Equal volumes of 2000 N_2O_3 and 5000 N_2O_5; the nitrate could be detected with great certainty by orcinol, but with phenol the results were irregular, reaction being sometimes fairly good, but often unsatisfactory.

When nitrous acid is destroyed by SO_2 in presence of nitric a portion of the latter is always destroyed; the residue gets beyond the reach of phenol when much nitrous acid was present.

The following mixtures were tested for nitrate by adding two drops SO_2, one drop HCl, one drop copper solution, and two drops orcinol to each test; not less than four were made with each mixture, and the experiments, besides, have been several times repeated. Four tests were made at the same time for comparison with 2000 N_2O_3 only; to each of these all reagents as above were added. We may call these blank tests.

No. 1.—1 c.c. 6000 N_2O_5 mixed with 10 c.c. 2000 N_2O_3,
No. 2.—The above diluted with an equal volume of water.

No. 1.—In ten minutes distinct bands. Three hours might be called strong; six hours strong, excellent bands.

No. 2.—As above. In three hours could not be distinguished from the tests with double strength solution. The blanks even after nine hours were a pale pink—immense contrast to above.

I have not carried the experiment further, because, unless the tests present a *striking* contrast to the blanks, the results will be unreliable. If the copper is omitted the blanks will be colourless, but of course the copper would then have to be left out of the tests also. The bands, as already stated, would then take much longer to develope and would be much weaker.

In No. 1 and No. 2 the N_2O_3 was present in the proportion of 30 to 1 of N_2O_5. In No. 2 the dilution of N_2O_5 was 132,000. As the bands were about as strong with No. 2 as with No. 1 it would appear concentration is one of the factors involved in destruction of the nitrate.

(To be continued.)

THE RELATIVE VALUES OF THE WEIGHTS OF HYDROGEN AND OXYGEN.*

By JOSIAH PARSONS COOKE and THEODORE WILLIAM RICHARDS.

(Continued from p. 10).

Apparatus for Weighing Hydrogen.

In entering on a new investigation of the oxygen and hydrogen ratio, it was evident at the outset that no advantage was to be gained by multiplying determinations by the old method. The only hope of improvement lay in finding some method of weighing the hydrogen with sufficient accuracy; and it was essential to determine this weight to within one ten-thousandth, or at least one five-thousandth, of its value.

A gas can only be weighed by enclosing it in a glass globe, or some similar receiver, and hydrogen is so exceedingly light that its total weight can only be a very small fraction of the weight of the containing vessel. Moreover, as the buoyancy of the air is fourteen and one-half times as great as the weight of the hydrogen, the variations in buoyancy caused by changing atmospheric conditions have an all-important effect on the apparent weight. The late Professor Regnault, of Paris, devised, however, a very ingenious method of compensation, which could readily be applied in this case. It consisted in balancing the globe containing hydrogen, hung to one arm of the balance, by a second globe of exactly the same external volume and made of the same material, hung to the opposite arm; and so arranging the balance case that they should hang in the same enclosure, and therefore be equally affected by atmospheric changes. This method was applied in the problem before us, and after a number of trials it was found possible to make the compensation so accurate that under good conditions the weight of a globe holding five litres of gas did not vary more than one-tenth of a milligrm. through large changes of temperature and pressure. In order now to weigh hydrogen with this apparatus, it was only necessary to exhaust the air from the glass receiver, and, after balancing it as described, to fill it with pure gas, when the increased weight—less than half a grm. with our apparatus—was the weight of hydrogen required.

The balance employed was an excellent one, made about twenty years ago by Becker and Sons, of New York. With

* Contributions from the Chemical Laboratory of Harvard College. From the *Proceedings of the American Academy of Arts and Sciences*, vol. xxxiii.

a load of five hundred grms. in each pan it turns very perceptibly with one-tenth of a milligrm., and shows this small difference of weight with very great constancy.

The globe and its counterpoise were hung from hooks soldered to the bottoms of the pans by means of wires which swung freely through small holes made for the purpose through the bottom of the balance case, and also through the top of the shelf on which the case stood. The enclosure in which the globe and its counterpoise hung was a box made of tinned iron fastened to the bottom of the shelf, and having doors in front like an oven, through which the globe could be removed or hung in position. This case was coated with lampblack on the inside, in order to secure uniformity of temperature, and the air was kept dry by means of two large dishes of sulphuric acid, placed on shelves at the top of the case. We first placed the sulphuric acid dishes on the bottom of the case in the usual way, but we found it impossible thus to secure a uniform condition of the atmosphere within; and as moist air is necessarily lighter than an equal volume of dry air at the same temperature and pressure, it is obvious that any drying material will have the greatest efficiency when placed near the top of the space to be protected. The tin

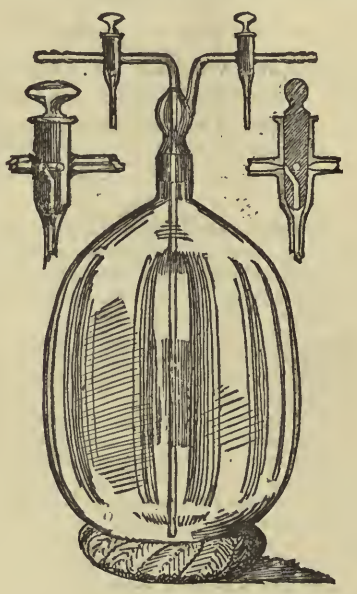

Fig. 1.

box was itself enclosed in a cupboard, but not otherwise protected, and the balance case was surrounded by curtains, in order to shield the beam from radiation.

With the apparatus so arranged it was found possible to obtain most satisfactory and concordant results to tenths of a milligrm. when the change in the temperature of the balance-room was not very rapid; but any sudden changes produced by artificial heating would cause slight currents of air in the interior of the case, whose effect became very sensible, but whose influence we were able to eliminate. The best series of results, however (the second series in the table given later on), was obtained during the month of June, when there was no artificial heat in the building, and the temperature varied but little during day and night.

The globe used for holding the hydrogen—shown in Fig. 1 in about one-sixth of its actual dimensions—has an interior capacity of 4961·5 c.c., and weighs 570·5 grms. The cap with the connecting tubes was ground into the neck, and this joint, as also the stopcocks, was so carefully made that there was absolutely no leakage, and the globe would hold a vacuum indefinitely, as was shown frequently by its remaining hung on the balance for weeks together when exhausted without change of weight. The apparatus was made by Emil Greiner, of 79, Nassau Street, New York, whose careful workmanship greatly contributed to the success of our investigation. The details of the stopcock are shown at the sides, and it will be noticed that, besides the direct way, there is a side way through the plug of the stopcock independent of the first, by which, when the stopcock is closed, a connection is established with the base of the cock, through which the gas may escape.

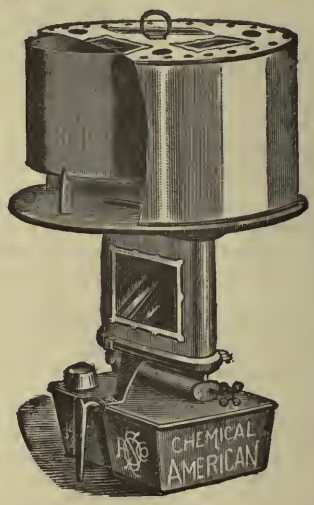

Fig. 2.

Assume now that the interior of the globe has been exhausted, and a gas current established through this side aperture from one of the generators employed. On turning the stopcock the side aperture is first closed, and then the direct way slightly opened, so that all the gas evolved now passes into the globe; and it was found possible to regulate the current with such nicety as not to cause any sudden changes of tension in the generator, which was

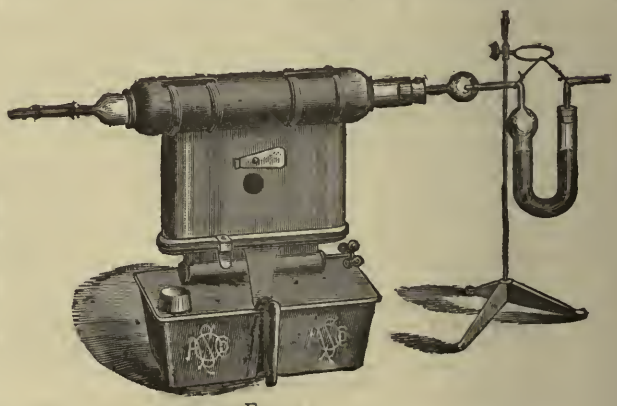

Fig. 3.

always provided with an overflow by means of which the tension could be watched, and according to which the stopcock was regulated.

The filling of the globe was one of the critical points of the determination. It generally occupied from one to two hours, and during all this time it was necessary, with the hand on the stopcock, carefully to watch the tension at the overflow already mentioned, and represented in Fig. 5 and Figs. 7 and 8. From the beginning to the end of the operation there was a greater tension in the generator than

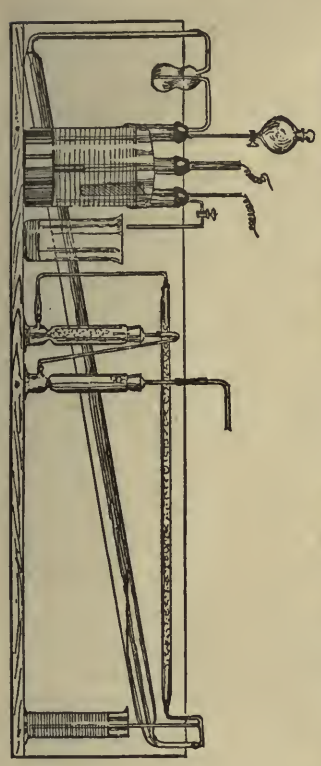

Fig. 7.

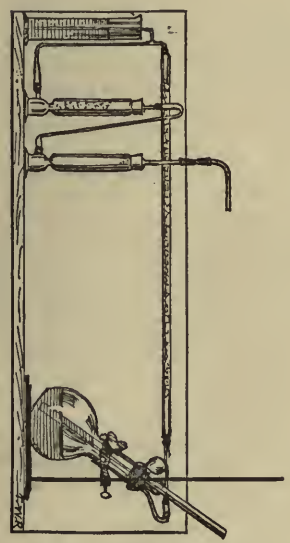

Fig. 8.

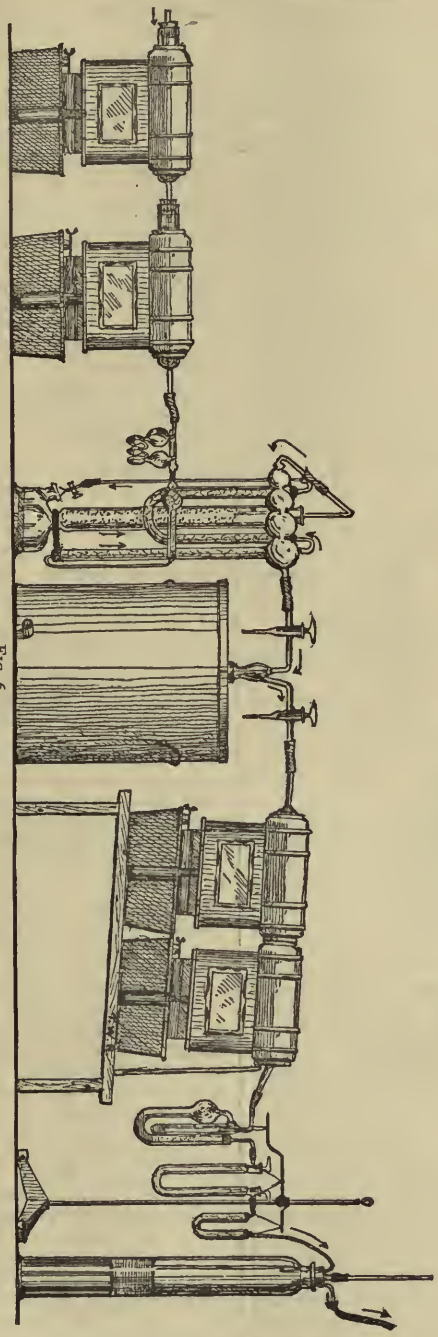

Fig. 6.

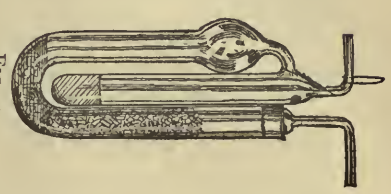

Fig. 4.

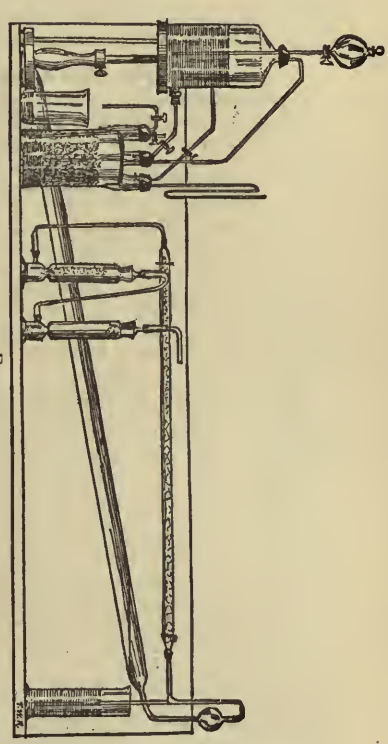

Fig. 5.

in the outside air by about one inch of mercury. When the connection was once established between the generator and the globe there was absolutely no leakage through the side way, as was tested in several cases by dipping the mouth of the tube at the base of the cock under mercury.

The whole process of weighing the hydrogen was finally reduced to the following manipulation. The globe was connected by means of a rubber hose with a rotatory air-pump having automatic valves, made by E. S. Ritchie, of Boston. It was then exhausted to within 1 m.m. of mercury. Next, closing the cock and disconnecting the globe, it was cleaned with distilled water and fine cotton cloth; at least, this was done five or six times during the determinations. But as the globe when out of the balance case was always protected by a cylindrical tin box with a cover, from which the exit tubes projected, it was usually only necessary to clean the exit tubes in this careful manner, simply dusting off the globe with a large camel's-hair brush before hanging it in the balance case. In this part of the operation it was necessary to take care not to communicate to the globe a charge of electricity by rubbing it with a perfectly dry cloth.

The globe was hung on a wire stirrup, which caught the exit tubes, as the glass joint was sufficiently strong to support the weight of the globe. The globe was so nearly balanced by its equipoise that when exhausted it only required about one decigrm. to establish equilibrium. The time required to attain perfect equilibrium varied with the conditions. If the glass had been previously cleaned as described above, perfect equilibrium might not be reached for forty-eight hours, or even longer, while if the glass had only been dusted, twelve hours were generally sufficient.

After the tare had thus been taken the globe was removed from the balance, placed in the protecting case, and filled with hydrogen as just described. The inlet tube, to which a rubber connector had been attached, was scrupulously clean as before, and the globe was again dusted and hung on the balance. During all these transfers the globe was always handled with clean cotton cloth and the hands never came in contact with the glass. The increased weight was now the weight of the hydrogen; and as the volumes equipoised were exactly the same, and the additional weight was represented by less than five-tenths of a grm. of platinum, any correction for the buoyancy of the atmosphere is unessential.

Combustion Apparatus.

The apparatus by which the combustion of the hydrogen was made is represented in Fig. 6. It is made up of a series of small combustion furnaces, which are a modification of a kerosene-oil stove called "the American," very much used in the United States. This stove, as adapted to chemical uses by the writer, is shown in Figs. 2 and 3, and it has proved of great value, not only for elementary chemical experiments in school courses, where illuminating gas is not to be had, but also in a well equipped chemical laboratory. The stove is made for burning kerosene oil, but alcohol can also be burnt in it with decided advantage for chemical work. The figure of the stove has been drawn to about one-sixth of the actual size.

In the figure of the combustion apparatus (Fig. 6) it will be noticed that the globe, protected by its case, stands about in the middle of the line. By means of a suction pump attached to the extreme right of the apparatus, a current of air is maintained through the whole length. Beginning now at the extreme left, the air first passes over reduced copper, and is deprived of its oxygen. It next passes over cupric oxide, by which any traces of hydrogen that had remained occluded by the reduced copper, or any traces of hydrocarbons in the air itself, are burnt. It next passes through caustic potash bulbs, and then through a system of driers, meeting successively calcic chloride, sulphuric acid, and phosphoric pentoxide. It now enters the globe through the inlet tube reaching to the bottom, carrying before it the hydrogen into the combustion furnace.

The water from the combustion was collected in a condenser—the details of whose construction are represented in Fig. 4—which was shielded from the furnace by a screen of asbestos paper. Nine-tenths of the water was condensed in the middle tube, and all but the last traces of the aqueous vapour were absorbed by the sulphuric acid through which the air subsequently bubbled up at the end of the U-tube, between glass beads, which broke the ascent and divided the bubbles. With this condenser was connected a U-tube containing phosphoric pentoxide, which absorbed the last traces of the aqueous vapour, seldom, however, gaining in weight more than two m.grms. during a combustion lasting from seven to eight hours. Then follows a safety tube containing calcic chloride (or in some cases phosphoric pentoxide), to prevent any reflex diffusion, and finally an adaptation of the principle of Mariotte's flask to regulate the velocity of the air current. It will be seen that the open mouth of the central tube of this last apparatus dips under the mercury in the tall jar, so that by raising or lowering it the strength of the current could be exactly regulated.

Before beginning a combustion the place of the hydrogen globe was supplied by a straight piece of glass tubing, and the air current maintained through the heated combustion tube until the cupric oxide was perfectly dry. Next, the furnace at the extreme left was lighted, and the current continued until the oxygen in the air of the drying tubes had been so far replaced by nitrogen as to remove all risk of subsequent explosion.

Meanwhile the globe and condensing tubes were made ready, and first the globe and next the condensing tubes were placed in position, all the rubber connectors required having been previously dried in the current of dry air, and the joints were so contrived that subsequently the stream of gas came in contact with the smallest possible surface of the rubber connectors. The combustion lasted, as has been already stated, from seven to eight hours, and during this time quite a rapid current of air was drawn through the apparatus.

Our preliminary experiments plainly showed that the rapidity of the current within practicable limits had no appreciable effect on our results, and this is due to the fact that the current entered the globe and left the condensers under precisely the same conditions. More than nine-tenths of the water was condensed during the first half-hour, the drops falling regularly from the mouth of the inlet tube, and after two hours all traces of cloudiness disappeared from this tube or its connections, showing that the air coming over was perfectly dry. The water thus collected was absolutely clear and limpid.

After the first hour the combustion furnace used for removing oxygen from the air, at the extreme left, was taken away, and by the end of the combustion the reduced copper in the combustion tube proper was again completely oxidised, leaving the globe and all the tubes filled with normal air, as at the beginning of the process. It only remained now to remove the condensers, and reweigh them with all necessary precautions. At both weighings the barometer and thermometer were observed, and the small, usually insignificant, correction for buoyancy caused by a change in the atmosphere during the interval was carefully estimated.

The question of the time of running the combustion after the production of water had sensibly ceased was one that was carefully considered. The time mentioned above —eight hours—was far outside the necessary limits, and was reached only after a large number of experiments. That a very long continuance of the current after the combustion was practically ended was unnecessary was clearly shown by several circumstances. In the first place, the duration of the combustion beyond the limit we have named made no difference in our results, as was repeatedly shown. Again, in one instance, after detaching the condensation tubes and weighing them, they were again put in place and the combustion continued three hours longer, during which time the tubes gained no appreciable weight. In another instance, when a suspicion arose that possibly some hydrogen might be occluded on the walls of the globe, the condensation tubes having been dismounted and weighed as before, the globe was also dismounted and heated over the free flame of a Bunsen lamp to as high a temperature as the glass would safely bear, over 300° C., and then, the apparatus having been remounted, the combustion was continued for one hour. Here again the condensation tubes gained only a small fraction of a m.grm. in weight, an effect which might easily be accidental, and which was wholly without influence on the result.

(To be continued).

The Hydrochlorates of Antimony and Bismuth Terchlorides and Antimony Pentachloride. — R. Engel. — These three compounds are well-defined and easily isolable. All three contain water of crystallisation, there being at least two mols. of water for each mol. of hydrochloric acid fixed by the chloride.—*Comptes Rendus*, Vol. cvi., No. 26.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, June 21st, 1888.

Mr. William Crookes, F.R.S., President, in the Chair.

Messrs. George Embrey and Albert L. Guiterman, Ph.D., were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. John Burke Fairley, 2, Sidney Villas, Lower Eglinton Road, Shooter's Hill; A. Alexander Ramsay, Auckland, New Zealand; C. Heinrich Trinks, 117, King Henry's Road, N.W.

The following were elected Fellows of the Society:—Messrs. John Alexander, Charles Bradshaw, Lewis Edmunds, William Humphrey Gibson, Joseph Henry Maiden, Henry Alexander Miers, M.A., Frank Mousley, James H. Rymer Paterson, George Woodyatt Procter, Herbert W. Seely.

The following papers were read:—

48. "*Chlorofumaric and Chloromaleic Acids and their Magnetic Rotatory Powers.*" By W. H. Perkin, Ph.D., F.R.S.

The author has further studied the action of phosphorus pentachloride on tartaric acid, first examined by Mr. Duppa and himself in 1861. The main product is the chloride of *chlorofumaric acid*, not chloromaleic chloride as was formerly supposed. In the paper, the properties of the chloride are described, and also those of the acid and of its acid potassium, ammonium, and ethylic salts. On treatment with ammonia, the ethylic salt is first converted into the ethylic salt of chlorofumaramic acid,—

$$CO(NH_2)\cdot CH\cdot CCl\cdot CO_2Et,$$

a substance already described by Claus and Voeller as a maleic compound; on further treatment with ammonia, amidofumaramide is produced; this crystallises in pale yellow needles, and decomposes when heated, no definite fusing point being observable. Claus and Voeller, operating in the same manner, have, however, obtained a substance which, although of the same composition, crystallises in colourless scales, melting at 122°.

On heating a mixture of chlorofumaric acid and chlorofumaric chloride, chloromaleic anhydride is obtained; this substance is dimorphous, being obtainable in hard crystals melting at 34·5°, and as a solid which melts just below 0°. Chloromaleic acid and a number of its salts are fully described in the paper; like the maleates, the chloromaleates yield a brown-red colouration with ferric salts, while the chlorofumarates, like the fumarates, afford a buff precipitate with ferric salts. The magnetic rotatory powers of a number of the compounds described are recorded in the paper.

49. "*Combustion by means of Chromic Anhydride.*" By C. F. Cross and E. J. Bevan.

Ladenburg in 1865 described a method of ultimate analysis of carbon compounds, consisting in heating with iodic acid and sulphuric acid in sealed tubes; the oxidation was found complete for a satisfactory variety of substances, and the experimental numbers obtained showed the process to be available as a laboratory method of estimating carbon and hydrogen.

The authors have investigated the action of chromic anhydride in presence of sulphuric acid on carbon compounds. Ladenburg mentions this "combustion mixture," but regards it as unavailable for quantitative determinations on account of the CrO_3 decomposing with evolution of oxygen. This, however, is shown by the author's experiments to take place to so small an extent under the conditions as to time and temperature of a combustion, that it may be neglected.

The action of the mixture has been investigated under atmospheric pressure in vessels connected with a gas collecting and measuring apparatus. The carbon of the celluloses and carbohydrates is entirely converted into gaseous products. Some typical benzenoid compounds have also been investigated, and the results indicate that complete oxidation may be effected. The monobasic acids of the fatty series on the other hand are not completely resolved, and the results are consequently variable. Amide and imide nitrogen prevent complete oxidation; one of the causes probably being that urea is not attacked by the mixture. Compounds containing negative radicles, such as Cl, Br, S, and NO_2, have not been investigated.

Discussion.

Mr. A. H. Allen said that he had been in the habit for years of using chromic anhydride for oxidising carbon in steel, but he had found that some carbon dioxide was always evolved when pure sulphuric acid and the commercial anhydride were used; he therefore prepared the solution of the anhydride from fused lead chromate and sulphuric acid.

50. "*Metaxylenesulphonic Acids.*" By G. T. Moody, D.Sc.

According to Jacobsen, metaxylene yields two sulphonic acids; the 1 : 3 : 4 modification is the chief product, the 1 : 2 : 3 modification being also formed, and in larger quantity when the temperature during sulphonation is low. The primary object the author had in view was to ascertain if the 1 : 2 : 3 acid was convertible by isomeric change into the isomeride, the investigation being one of a series which are being carried on in the Central Institution Laboratory for reasons briefly stated by Dr. Armstrong in Abstract No. 99, 1887.

The author arrives at the conclusion that the contradictory results obtained by Jacobsen, Remsen, and others on sulphonating metaxylene, are to be explained by the fact that in their investigations they did not use a pure hydrocarbon. Metaxylenesulphonic acid, obtained by sulphonating crude metaxylene, may be freed from paraxylenesulphonic acid and other impurities by *repeatedly* crystallising it from sulphuric acid diluted with one-third its weight of water in the manner described by Jacobsen, who, however, clearly did not carry the purification far enough. The pure sodium salt differs greatly from the description of it given by Jacobsen (*Berichte*, 1878, 17). It crystallises in beautiful tables belonging, in all probability, to the anorthic system, and contains one molecule of water of crystallisation. When hydrolysed, the pure sodium salt yields a hydrocarbon which on sulphonation with chlorosulphonic or sulphuric acid, gives *only one* sulphonic acid, the sulphonamide prepared from which melts at 137°.

Jacobsen's sulphonamide, melting at 95—96°, is not a derivative of metaxylene at all, but a mixture containing a considerable quantity of paraxylenesulphonamide; the solid xylenol obtained from it by Jacobsen being identical with paraxylenol, which he describes in the same paper.

Dibromometaxylenesulphonic acid, on reduction with zinc-dust and sodium hydroxide, yields a sulphonic acid, the barium salt of which crystallises in large prisms, the sulphochloride in prisms melting at 39°, and the sulphonamide in slender brittle needles, melting at 113°. Jacobsen and Weinberg obtained this sulphonamide in an impure condition (*Berichte*, 1878, 1534), and regarded it as identical with that melting at 95—96° obtained by Jacobsen on sulphonating "metaxylene" with sulphuric acid.

If the sulphonic acid giving the sulphonamide, melting at 113°, be heated at 100°, isomeric change readily occurs, and the acid corresponding to the amide, melting at 137°, is formed.

The author proposes to closely study the derivatives of the acid yielding the amide, melting at 113°.

51. "*The Formation of Isomeric Toluenesulphonic Acids.*" By Hugh Gordon, B.A.

The object which the author has had in view was

similar to that by which the author of the previous communication was guided. It is well known that when toluene is sulphonated at low temperatures a large proportion of ortho-acid is obtained, whereas if sulphonation be effected at a temperature near the boiling-point of toluene, the para-acid is the almost exclusive product; it is obviously important, if possible, to determine whether or no the para-acid is formed from the ortho-acid by simple isomeric change. The author finds that tolueneorthosulphonic acid (hydrated) is not affected by heating at 100°, but by somewhat prolonged heating at 140—150° it is converted into the para-acid; and inasmuch as this temperature is far above that at which toluene boils, it appears improbable that the ortho-acid becomes hydrolysed, and that the para-acid is formed by re-sulphonation of the toluene at a high temperature. The results as yet obtained are regarded, however, as incomplete, an extended investigation of the behaviour of the various sulphonic acids, both of toluene and of toluene-derivatives, being in progress.

52. "*A New Method for the Preparation of Mixed Tertiary Phosphines.*" By Norman Collie, Ph.D.

The author has already called attention to the way in which when heated compound phosphonium chlorides decompose into the chlorhydride of the tertiary phosphine and an olefine. He has since used this as a method for the preparation of mixed tertiary phosphines. Triethylphosphine has been united with methyl, propyl, amyl, and benzyl chlorides respectively; all these compound phosphonium chlorides, when heated, decompose in a manner similar to the tetrethylphosphonium chloride, yielding ethylene and chlorhydrides of the tertiary phosphines.

The tertiary phosphines were prepared from the chlorhydride by the action of caustic soda. In this manner the following phosphines have been obtained:—Methyldiethylphosphine, dimethylethylphosphine, propyldiethylphosphine, amyldiethylphosphine, benzyldiethylphosphine, and dibenzylethylphosphine.

53. "*Some Interactions of the Halogen Hydrides.*" By G. H. Bailey and G. J. Fowler.

The authors have found that when phosphorus pentoxide is exposed to hydrogen chloride gas at ordinary temperatures, large quantities of the gas are taken up by it, amounting to nearly a quarter of a litre per grm. of the pentoxide, the gas and the pentoxide interacting chemically: $2P_2O_5+3HCl=POCl_3+3HPO_3$.

A similar interaction occurs with hydrogen bromide, but none with hydrogen iodide. They have also observed that though hydrogen chloride has no action on mercury, yet if mixed with oxygen it readily attacks the mercury, forming an oxychloride, $Hg_2OCl_2 \cdot HgO$, action taking place even in the dark. With hydrogen, bromide, gas, and oxygen the interaction is more rapid, but whereas in the case of the chloride the whole of the hydrogen is oxidised to water, in the case of the bromide a large proportion remains uncombined. Hydrogen iodide gas forms with mercury mercurous iodide or mercuric iodide according as the mercury or the iodide is in excess.

54. "*Remarks on the Paper of Drs. Japp and Klingemann on the Constitution of certain so-called Mixed Azo-Compounds.*" By Prof. Victor Meyer.

From a note on page 523 of the above-named article (*Chem. Soc. Trans.*, 1888), I see that Messrs. Japp and Klingemann regard my "Nachschrift," in the *Berichte* (1888, p. 18), as a claim of priority on my part. On reperusing the article I see that the wording, quite unintentionally on my part, permits of such a reading. I therefore hasten to explain that the results there referred to were arrived at by Messrs. Japp and Klingemann and myself, independently, and that without doubt they obtained theirs ere I did mine. Nothing is further from my thoughts than the desire to detract from the merits of these workers, especially in a field which they have enlarged by such valuable and successful investigations.

55. "*The Action of Potassium on Tetralkylammonium Iodides.*" By C. M. Thompson and J. T. Cundall.

According to Weyl, if potassium in solution in liquid ammonia act on ammonium chloride, ammonium is produced and dissolves in the ammonia, forming a blue solution; this statement lacks confirmation, and has even been contradicted. In the hope of obtaining more decisive results, the authors have substituted tetramethyl- and phenyltrimethyl-ammonium iodide for ammonium chloride, but unsuccessfully. The greater part of the former was unchanged, a portion only being acted on by the potassium giving potassium iodide, ethane, and trimethylamine; from the latter, potassium iodide, dimethylaniline, and trimethylamine were obtained.

56. "*The Solubility of Isomeric Organic Compounds in Relation to their Fusibility.*" By Thomas Carnelley, D.Sc., and Andrew Thomson, D.Sc., M.A., University College, Dundee.

Seven years ago (*Phil. Mag.*, [5], xiii., 180) one of the authors showed that the fusibility and solubility of isomeric compounds were very closely related to one another, so that of two or more isomeric bodies, that dissolves the most easily which has the lowest melting-point, and in which the atomic arrangement is the least symmetrical. At that time the investigation had included only a comparatively small number (58) of compounds. The authors have now extended the investigation, so as to include all isomeric sets of carbon compounds whatever. Their data have been obtained partly from literature and partly as the results of their own determinations. The following are their general conclusions:—

(1.) For any series of isomeric carbon compounds the order of solubility is the same as the order of fusibility, *i e.*, the most fusible compound is also the most soluble. This rule has been applied in 1778 cases, of which 1755 accord with the rule, including all kinds of isomers, from the most simple to the most complicated. There are only 23 exceptions, and a large proportion of these is of a very doubtful character.

(2.) The order of solubility of the corresponding salts of any series of isomeric organic acids is the same as that of the acids themselves, *i e.*, the salts of the more soluble and more fusible acids are also more easily soluble than the corresponding salts of the less soluble and less fusible acids; and if fusible more easily fusible, but the melting-points of most organic salts cannot be determined because they decompose before fusion. To this rule there are five exceptions out of 143 cases in which the rule can be applied, and as regards at least three of these it is very doubtful whether they are real exceptions.

(3.) The order of solubility of two or more isomeric compounds is independent of the nature of the solvent. This rule can be applied in no less than 666 cases, and among these there is not a single exception. The truth of the rule has also been proved more particularly in the case of meta- and para-nitraniline, the solubility of each of which in 13 different solvents has been carefully determined.

(4.) The ratio of the solubility of two isomers in any solvent is constant, and is independent of the nature of the solvent; this has been proved as yet only in the case of the meta- and para-nitranilines in respect of 13 different and very varied solvents.

The extremely close and intimate relation of solubility to fusibility, however, is proved not only by the very large number of cases of isomeric compounds which the authors have examined (nearly 2000), but also by the relative fusibility and solubility of the various allotropic modifications of the same element (*e.g.*, P, S (?), Se), and of mixtures of organic compounds (*e.g.*, solid paraffins), and of inorganic salts (*e.g.*, sodium and potassium nitrates), in all of which it is pointed out that the order of solubility is the same as the order of fusibility, and that this order is independent of the nature of the solvent.

The curve of the solubility of mixtures of sodium and potassium nitrates in various proportions is very striking.

Starting with pure sodium nitrate, the solubility increases and the curve rapidly falls as the percentage of $NaNO_3$ diminishes and that of KNO_3 increases, until the proportion of the latter amounts to about 20 per cent; the solubility then remains constant and the curve becomes a horizontal line until the proportion of the potassium salt reaches about 40 per cent, after which the solubility diminishes and the curve rapidly rises until pure KNO_3 is reached. The curve of fusibility falls rapidly from pure $NaNO_3$, until the latter amounts to 50 per cent, after which it remains constant until the KNO_3 equals 60 per cent, and then rises rapidly until pure KNO_3 is reached.

57. "*Notes on some Compounds of Chromium.*" By Sydney Lupton, M.A.

The determination of the atomic weight of chromium has occupied the attention of many chemists, but from a variety of causes the results obtained are far from satisfactory. In some cases single experiments are relied on, and in others proper attention has not been paid to the solubility of silver chloride in solutions of chromic chloride, the great difficulty of drying chromic sulphate without decomposition and of completely decomposing it by heat, the liability of barium chromate to carry down other salts, or to be carried down by barium sulphate. Hence the true atomic weight cannot be considered to be determined to within about 1 per cent. In fact Clarke, placing apparently great reliance on a single experiment of Siewert's, takes Cr=52·01; while Meyer and Seubert, giving greater weight to the experiments of Berlin, assume Cr=52·45, which is practically the value preferred by Fresenius.

The following experiments were made with the object of suggesting a method for the determination of the atomic weight of chromium free from the defects inherent in all the methods which have hitherto been used. Incidentally a few old results have been either confirmed or rendered doubtful.

Potassium Dichromate.—The density of this salt was found by Thomson to be 1·98, which is copied into such authorities as Wurtz's "Dictionnaire" and Biedermann's "Chemiker Kalendar," 1884. Karsten found 2·6; Miller's "Elements" gives 2·62; Schrœder found about 2·7. The density of some small crystals of the twice re-crystallised salt was determined in benzene, the air being removed by a small hand-pump; it was found to be (i.) 2·69, (ii.) 2·67.

Ammonium Dichromate.—The density is given by Clarke as 2·151. Three experiments in benzene, the air being removed by a small pump, gave (i.) 2·16, (ii.) 2·18, (iii.) 2·75, and one in chloroform (iv.), 2·18

100 grms. of water dissolve—

At 7·0°	about	23	grms. of the salt;	at 60°	about	82	grms.
„ 10·0	„	24	„	94	„	115	„
„ 16·5	„	28	„	107	„	173	„
„ 18·0	„	33	„				

The solution boils at 107° C.; its density is 1·12 at 10°, and 1·158 at 18° C.

The finely-powdered salt is easily dried at 110° in the air-bath.

Darby states (*Jour. Chem. Soc.*, i., 20) that ammonium dichromate decomposes suddenly when heated to 200°. A small quantity of the dry powdered salt was heated in a thin test-tube, with a thermometer inside placed in a paraffin bath. Sudden decomposition took place at (i.) 228° C.; (ii.), 230° C.

Since the composition of the salt has been placed beyond doubt by Siewert (*Jahresb.*, 1862, 148), the ignition of ammonium dichromate and the determination of the chromic oxide left seems in theory to afford an unexceptionable method of determining the atomic weight; but the difficulty of avoiding loss of oxide by the sudden rush of the gas is very great. Darby used tubes plugged with cotton-wool, Richmond and Abel tubes plugged with asbestos, and I have tried mixing the salt with a large excess of ignited silica without success. Hence it seemed advisable to reduce the salt previous to ignition to obtain the oxide. The reduction with hydrogen dioxide is rather tedious, and it is somewhat difficult to obtain a solution of the dioxide which leaves no residue on ignition. A solution of sulphur dioxide was therefore used as the reducing agent. 0·1539 grm. of ammonium dichromate was dissolved, reduced by sulphur dioxide, evaporated, and the residue heated for two hours at 200°, when the residue weighed 0·3228 grm., which was reduced to 0·3218 grm. by further heating during an hour and a half; this residue nearly corresponds to the formula $Cr_2 3SO_4 7H_2O$. After long-continued heating over a good argand, the residue consisted of a mixture of sulphate and oxide, which, when heated over a Bunsen to bright redness for two and a half hours, gave a residue weighing 0·1021 grm., which remained unchanged after heating for another hour. Hence, one part of ammonium dichromate left 0·6634 part of residue, the formula of which would be about—

$$Cr_2 3SO_4 15Cr_2O_3,$$

instead of 0·60 required for Cr_2O_3. A second experiment gave similar results, and even prolonged ignition over a gas blowpipe failed to produce the mass to oxide. This difficulty in drying chromic sulphate, and in decomposing it by heat, explains the high value Cr=53·563 obtained by Moberg by the ignition of chromic sulphate and of ammonio-chromic alum. Reduction with (i.) hydrogen oxalate, (ii.) alcohol and hydrogen nitrate, (iii.) alcohol and hydrogen chloride is liable to occasion loss by spitting.

Mercurous Chromates.—These salts have been investigated by Vauquelin, Godon, Gmelin, Darby, and Treese, but the results obtained are not very concordant. On pouring potassium dichromate into mercurous nitrate slightly acidulated with nitric acid, a heavy orange-red precipitate falls. Gmelin states that on heating this salt Godon obtained 0·126 part, and he himself 0·1232 part of oxide. One part of $Hg_2O{\cdot}4Hg_2CrO_4$ when heated would leave about 0·1232 part of oxide. According to Darby, the precipitate is of the composition $Hg_2O{\cdot}3Hg_2CrO_4$, but he does not state that he himself analysed it. It is slightly soluble in water, and easily soluble in hot dilute nitric acid, from which it separates on cooling as the normal salt Hg_2CrO_4. From one part of this salt Darby obtained by ignition (i.) 0·1463, (ii.) 0·1488, (iii.) 0·1479, part of chromic acid. *Wurtz's Dict.*, i., 896, assigns to Godon and Gmelin's salt the formula $Hg_2OHg_2CrO_4$, and Treese (*Zeit. f. Chemie* [2], vi., 30), states that the salt thus obtained is normal and not decomposed by water.

1·7334 grms. of mercurous chromate obtained from Messrs. Hopkin and Williams were heated over a Bunsen burner until a dull green residue weighing 0·1943 grm. was left. The ratio is 1 : 0·1127, and a second experiment, in which a slight loss occurred, gave 1 : 0·1118. This corresponds fairly to the salt $Hg_2O{\cdot}3Hg_2CrO_4$ containing a little impurity or traces of mercurous oxide.

A hot solution of potassium dichromate was poured into a hot solution of mercurous nitrate slightly acidulated with hydrogen nitrate. The fine heavy orange precipitate was washed, dried on the water-bath, and heated at 120° C., until it ceased to lose weight. Four experiments on the ignition of this salt gave the ratios—

(i.) 1 : 0·1523	(iii.) 1 : 0·1516
(ii.) 1 : 0·1517	(iv.) 1 : 0·1510

This powder then appears to be normal mercurous chromate containing a small proportion of either mercuric chromate or mercurous dichromate. A quantity of it was boiled for some time with dilute nitric acid, and the undissolved residue was washed and dried. 1·5525 grms. left on ignition 0·2294 grm. of oxide, corresponding to the ratio 1 : 0·1477. Hence the undissolved residue seems to be normal mercurous chromate, Hg_2CrO_4.

In conclusion, two methods for the determination of the atomic weight of chromium seem to suggest themselves:—

1st. The reduction of ammonium dichromate at a low temperature by a weak solution of hydrogen oxalate, or of

some similar reducing agent, and the determination of the chromic oxide left on ignition.

2nd. The ignition of normal mercurous chromate and determination of the chromic oxide.

In the first case the required atomic weights are well known, but the purification of the dichromate is tedious, and the reducing agent causes additional chance of error. In the second case the chromate is more easily purified, but the results will be affected by the uncertainty still attaching to the atomic weight of mercury.

58. "*The Estimation of Alumina and Free Sulphuric Acid in Alum Cake and Sulphate of Alumina.*" By Rowland Williams.

The author recommends Chancel's method of estimating alumina by boiling with sodium thiosulphate (*Watts's Dictionary*, i., 155) as more accurate and expeditious than the ammonia process. In support he quotes the following results :—

	"Ammonia" method.	"Thiosulphate" method.	Theory.
Alums (pure).			
Potash alum	11·01	10·76	10·81
Ammonia alum.. ..	11·50	11·24	11·31
Alum Cakes.			
No. 1 sample	12·94	12·66	—
No. 2 „	12·34	12·21	—
No. 3 „	12·93	12·42	—
Sulphates of Alumina.			
No. 1 sample	12·95	12·75	—
No. 2 „	13·51	13·21	—
No. 3 „	13·33	13·12	—
No. 4 „	14·62	14·41	—
No. 5 „	15·11	15·01	—
No. 6 „	14·81	14·68	—

The estimation of the free acid in alum cake, &c., is best effected by the following process :—300 grains of the sample are weighed into a stoppered bottle and 1200 grains measure of strong alcohol added, the contents of the bottle being frequently shaken, and the digestion allowed to proceed all night. The next morning the alcohol is filtered off and 800 grains measure of the filtrate (equal to 200 grains of the sample) titrated with decinormal caustic soda. Experiment shows that the alcohol does not extract other matters beside sulphuric acid which are liable to affect the result. To further test the accuracy of the method, ordinary sulphate of alumina was freed from sulphuric acid by washing with alcohol, and known amounts of acid were then added, and the amount estimated by the process described ; the results were as follows :—

Percentages of Free Sulphuric Acid.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Added..	0·73	1·22	0·98	0·49	0·59
Found..	0·69	1·19	0·96	0·44	0·54

ROYAL INSTITUTION OF GREAT BRITAIN

General Monthly Meeting, Monday, July 2, 1888.

John Rae, M.D., F.R.S., Vice-President, in the Chair.

The following were elected Members of the Royal Institution :—A. Gordon Salamon, F.C.S., F.I.C., and Thomas Graham Young, F.R.S.E.

The special thanks of the Members were returned for the following donations to the Fund for the Promotion of Experimental Research :—

Ludwig Mond	£100
John Bell Sedgwick	25
Mrs. Bell Sedgwick	25

The presents received since the last meeting were laid on the table, and the thanks of the Members returned for the same.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of emperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvi., No. 26, June 25, 1888.

The Vapour Density and Molecular Weight of Aluminium Chloride.—C. Friedel and J. M. Crafts.—Aluminium chloride volatilises without fusion under the ordinary atmospheric pressure, but it melts easily under a higher pressure. The authors find its melting-point intermediate between 186° and 190°. The boiling-point at 0·33 atmosphere is 167·8°, but at 3·60, 213°. The vapour-density at different temperatures ranges from 9·69 to 8·31, the theoretical value being 9·24. The numbers found do not fluctuate greatly over a range of more than 200°, and agree fairly well with those obtained by H. Sainte-Claire Deville and Troost (9·35 in the vapour of mercury and 9·349 in the vapour of sulphur. MM. Nilson and Petterson, who began their experiments only at 440°, obtain a decidedly lower value.

At What Degree of Oxidation do Chrome and Manganese exist in their Fluorescent Compounds?—Lecoq de Boisbaudran.—This question does not receive a definite answer.

On a Property of Carbon resembling that of Platinum-sponge.—G. A. Hirn.—The author, having blown out the flame of a spirit-lamp and put on its glass cover, saw accidentally, a few moments afterwards, that a point of the wick still remained glowing. One of the carbonised points was incandescent for nine hours over the extent of a square millimetre.

Artificial Reproduction of Phenacite and Emerald.—P. Hautefeuille and A. Perrey.—The former of these minerals is obtained from a mixture of silica, glucina, neutral lithia vanadiate, and lithia carbonate. Emerald was produced by using as mineralising agent acid lithia molybdate.

On the Alkaloids, the Proximate Principles of Human Urine.—Dr. Thudichum.—The substances identified and described are urochrome, omicholine, uropittine, uromelanine, urotheobromine (an isomer of theobromine differing from the latter in its properties), creatinine, reducine, parareducine, and aromine.

Bulletin de la Société Chimique de Paris. Vol. xlix., No. 5.

Silver Nitrate in Alcoholic Solution as a Reagent for the Acetylenic Carbides.—A. Béhal.—Silver nitrate in alcoholic solution appears to be the best reagent for the acetylenic carbides, especially those of high molecular weights.

Hydration of Tolane.—A. Béhal.—The process of hydration by sulphuric acid is applicable to the aromatic series. Distillation in a current of steam separates the desoxybenzoïne formed, and possibly decomposes the corresponding sulpho-conjugated derivatives which may have been formed. This method of operating may probably be used with success in the aromatic series to obtain alcohols with ethylenic derivatives and acetones with acetylenic derivatives.

A Pretended Reaction for Phloroglucine.—MM. Cazeneuve and Hugounenq.—The authors found that Weselsky's reaction (the yellow and then orange colouration followed by a vermilion-red precipitate given by potassium nitrite) may also be produced by phenol, resorcine, orcine, naphthol α and β in aqueous solutions at 1 part in 2000.

Compounds of Aluminium Chloride with Aceto-nitrile, with Acetonitrile Monochloride and Tri-chloride.—M. Genvresse.—Not suitable for abstraction.

Action of Certain Organic Acids upon Ordinary Oxalic Ether.—M. Lorin.—Oxalic, formic, and acetic acids act upon oxalic ether under conditions quite comparable. Latent alcohol is distributed, and there is produced the ether of the acid in reaction and of formic ether, which is in a twofold proportion when the reacting acid is the oxalic. The gaseous phenomena are of the same order.

Contributions to the Study of the Chlorides of the Bibasic Acids.—V. Auger.—The author examines the action of succinyl chloride upon benzene in presence of aluminium chloride; that of the same chloride upon ammonia, both aqueous and dry, and the action of aqueous ammonia upon phthalic anhydride and upon phthalyl chloride.

The Acetals of Normal Propyl-glycol.—H. Locher.—In this paper the author examines merely the cases of acetic and isovaleric aldehyds.

No. 6.

Examination of an English Coal.—MM. Scheurer-Kestner and Meunier Dollfus.—Already noticed.

Infusible Blue-black Enamel and its Applications on the Covering of Hard Porcelain.—Charles Lauth.—The author points out certain defects in the pure cobalt blues, and recommends, in preference, a mixture of 100 parts cobalt oxide, 88 parts manganese peroxide, and ferric oxide 44 parts. This mixture gives blues of a slightly grey tone, very soft, harmonising well with the whites and retaining its beauty by artificial light.

On the Covering Shell of Hard Porcelain.—Ch. Lauth and G. Dutailly.—The author discards the formula of Brongniart, on account of its tendency to chip off, and uses a mixture of sand, 37·69, kaolin, 35·38, manganese dioxide, 21·54, and colcothar, 5·39. After being twice furnaced this mixture gives;—Silica, 57·36; alumina, 14·20; manganese peroxide, 22·77; ferric oxide, 5·69.

Researches on Soft Porcelain.—Ch. Lauth and G. Dutailly.—This bulky memoir does not admit of abridgment.

Synthetic Formation of Toluyl-propionic Acid.—E. Burcker.—The author causes succinic anhydride to act upon toluene in presence of anhydrous aluminium chloride, and thus obtains tolyl-propionic acid. The reaction begins and may even be continued and completed at the common temperature.

Action of Chlorine upon Metallic Gold.—M. Lindet.—The author, on treating spongy metallic gold with chlorine, obtains a mixture of gold terchloride, gold monochloride, and metallic gold. As the temperature rises the proportion of the two chlorides increases at the expense of the metallic gold.

The Active Crystalline Matter of the Poisoned Arrows of the Somalis, extracted from Ouabäio Wood.—A. Arnaud.—This principle, which is not an alkaloid, is exceedingly poisonous, a few m.grms. proving fatal to large animals in a few minutes. It acts upon the heart.

Researches on the Colloidal State.—C. Winssinger.—The most remarkable conclusion reached is that the aptitude of the sulphides to assume and retain the colloidal state seems to be a periodic function of the atomic weights of the corresponding elements.

No. 7.

Action of Mono-chloro-acetonitrile upon Benzene in Presence of Aluminium Chloride.—P. Genvresse.—The principal products are benzoic acid and orthotoluic acid, the latter in small quantities.

On Blues under Cover.—Ch. Lauth and G. Dutailly.

Transformation of Œnanthylidene and Caprylidene, True Acetylenic Carbides, into Substituted Acetylenic Carbides under the Influence of Alcoholic Potassa.—A. Béhal.

Researches on Copper Reds.—Ch. Lauth and G. Dutailly.—These two long and exhaustive memoirs do not admit of abridgment. They are of the greatest value to artists on porcelain.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

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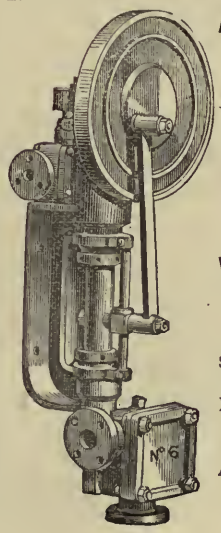

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1495.

COMBUSTION OF OXYGEN IN AMMONIA AND HYDROGEN IN NITRIC ACID.

By Dr. HODGKINSON and F. K. LOWNDES.

The experiment of burning oxygen in ammonia may be slightly modified by using a long platinum jet about 1 m.m. bore and 8 or 9 c.m. long. A good form of the experiment is to have the strong ammonia, 0·880, in a half litre flask with wide neck. Introduce the platinum tube, with escaping oxygen, to within a c.m. of the surface of the liquid, and set fire to the escaping gas mixture. The oxygen burns at the jet and raises the point to a white heat, whereupon it is lowered into the liquid ammonia. Here the oxygen continues to burn, and the platinum tube is generally melted. With a certain amount of oxygen pressure, easy to ascertain by a trial or two, white fumes of ammonium nitrate and nitrite escape from the flask or coat the upper part of the neck.

The converse experiment to this with hydrogen and nitric acid is still more striking. On introducing a small hydrogen flame by the platinum tube into concentrated nitric acid in the same sized flask as the ammonia experiment, several appearances may be obtained depending on the amount of hydrogen. With the platinum tube at a distance of 2 c.m. from the surface of the acid, and the pressure so arranged that the flame just touches the acid, the jet becomes heated to whiteness, and a fine coloured conical flame extends from the neck of the flask to the liquid surface, and white fumes of ammonium nitrate or nitrite escape. If the white-hot point of the tube be immersed under the acid, red fumes escape as well. The hydrogen continues to burn under the acid until it becomes considerably diluted. It is comparatively easy to regulate both experiments so as to produce ammonium salts.

DETECTION AND ESTIMATION OF BISMUTH AND LITHIUM IN METALLIC IRON AND SLAGS.

By H. N. WARREN, Research Analyst.

The slags operated upon in which the lithium and bismuth were detected were of ordinary blast-furnace production, and obtained from the smelting of ore from the Cleveland district, and consisting of an ordinary blast slag composition. Six slags, out of nine samples examined, gave a decided brownish precipitate after transmitting a current of SH_2 through a HCl solution containing 1 grm. of dissolved slag, and when 5 grms. were employed a decided black precipitate, which, when purified and estimated by the usual method, amounted in the various cases from 0·1 to 0·5 per cent of Bi_2O_3. The lithium estimated as carbonate. after the separation of the other ingredients, averaged from 0·05 to 0·1 per cent. The samples of iron examined, from which the slag had been produced, gave, as a mean percentage, from 0·01 to 0·04 of metallic bismuth, practically speaking the whole of the bismuth thus present passing into the slag. Out of six samples of the cast-iron examined, four samples, after separation of the iron and other ingredients present had been effected, gave, on attaching a small quantity of the residue to a platinum wire, and suspending the same in the flame of a Bunsen burner, a spectrum decidedly characteristic of lithium, when viewed by the aid of the spectroscope.

Everton Research Laboratory,
18, Albion Street, Everton, Liverpool.

ON THE

DETERMINATION OF THE AMOUNT OF MORPHIA PRESENT IN OPIUM.

By ROWLAND WILLIAMS.

In the Chemical News (vol. lvii., pp. 244—245) there appeared a paper by Messrs. Teschemacher and Smith. In justice to myself I must ask permission to correct a few of the errors contained therein.

Messrs. Teschemacher and Smith accuse me of adopting the title of their original paper without acknowledging its source. Now, in the *very first sentence* of my paper (Chemical News, vol. lvii., p. 134) I use the following words:—"I have read with much interest the paper bearing the above title by E. F. Teschemacher and J. Denham Smith, which recently appeared in the Chemical News (vol. lvii., pp. 93 and 103)."

Notwithstanding the disclaimer of Messrs. Teschemacher and Smith I still maintain that they were "in the same predicament" as myself with reference to the quantity of opium solution specified in the B. P. process. They seem to think *they* were bound to follow the process exactly, but that the same restriction did not apply to *myself*. If I worked by the B.P. process at all, it was quite as necessary for me to obey the instructions precisely as it was for Messrs. Teschemacher and Smith.

Messrs. Teschemacher and Smith next make the charge that I have been guilty of plagiarism from Mr. Stillwell. By reference to my letter to the Chemical News (vol. lv., p. 69), which Messrs. Teschemacher and Smith quote in connection with the question of titrating morphia with acid, they must have been aware that I had already given every credit to Mr. Stillwell.

Notwithstanding Messrs. Teschemacher and Smith's remarks about "my series of experiments," I again assert that for some time previous to the appearance of Mr. Stillwell's paper "On the Analysis of Opium" (Chemical News, vol. lv., pp. 41 and 54) I had been working on very similar principles to those laid down by him. In fact, when Mr. Stillwell's paper appeared I was engaged on an article for the Chemical News on the same subject, and was naturally rather disappointed to find myself forestalled. Consequently, I wrote the letter to the Chemical News, to which reference has already been made, and therein I explained the three chief points of difference between Mr. Stillwell's and my own plan of working. The most important of these is, I think, undoubtedly the third, viz., titration of the morphia with standard acid. The idea of claiming the titration with acid as original never entered my head, as the process has, I believe, been well known for some years in connection with other alkaloids besides morphia.

All that I urged was that titration with acid was decidedly preferable to treating the morphia precipitate with hot alcohol, as recommended by Mr. Stillwell, and I may say that Messrs. Teschemacher and Smith agree with me on this point.

Messrs. Teschemacher and Smith speak of my "curt and meaningless directions concerning the process which I at present employ for estimating morphia in opium." Surely it was unnecessary to repeat the exact details of manipulation, which I had already given on the previous page, the chief difference between the two processes being in the quantities of the respective reagents.

Messrs. T. and S. state that the change in my present method consists simply in using double the quantities which I formerly employed. As a matter of fact I use only *half* the amount of alcohol and *three-fourths* of the

quantity of ammonia of an entirely different sp. gr., the ether alone remaining in the same proportion as before.

Messrs. Teschemacher and Smith seem to doubt my statement concerning the results which I obtain by titrating the purified morphia precipitate. I still find my final figures to be about 0·25 per cent lower than those obtained by simply weighing the morphia. Our difference of opinion on this point may perhaps be partly due to the fact that I use *cold* water, whilst Messrs. Teschemacher and Smith use *warm*, for extracting the opium. Anyone who has worked by the two processes will certainly admit that my plan of working yields much cleaner and presumably, therefore, purer morphia, than Messrs. Teschemacher and Smith's method.

There is, however, not much difference between us in this respect. In their previous paper (Chemical News, vol. lvii., p. 103) they refer to a table on p. 94, and state that "the morphia crystals, freed from the rest of the opium alkaloids and from narcotin, lose very nearly 1 per cent in weight by titration." Now, on reference to this table I find that as the analyses were all made on *two hundred grains* of opium the actual average loss on titration was only 0·40 per cent, the highest being 0·52 per cent and the lowest 0·30 per cent.

I am surprised at Messrs. Teschemacher and Smith asserting that my statement is "wholly opposed to their own experience," when it is evident that their own figures, if correctly interpreted, prove beyond doubt the essential accuracy of my results.

Laboratory and Assay Office,
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PHENOL AND SOME ALLIED BODIES AS TESTS WITH CONCENTRATED SULPHURIC ACID FOR NITRITES, NITRATES, AND CHLORATES IN AQUEOUS SOLUTION.

By DAVID LINDO.

(Concluded from p. 17).

Nitrite and Chlorate.

In all cases equal volumes of the nitrite and chlorate solutions mixed. Sulphuric run in immediately after adding the other reagents.

20,000 N_2O_3 and 40,000 Cl_2O_5. Gave good red band with phenol. With 1 drop SO_2 and 1 drop orcinol blue band only. Nitrite destroyed, blue band due to chlorate faint.

10,000 N_2O_3 and 20,000 Cl_2O_5. Tested as above. Strong red band with phenol, blue band with orcinol distinct.

2000 N_2O_3 and 10,000 Cl_2O_5. Tested for chlorate only. Very distinct blue band.

4000 N_2O_3 and 20,000 Cl_2O_5. Tested as above. Blue band sufficiently distinct.

4000 Cl_2O_5 and 10,000 N_2O_3. Tested for nitrite only. Red, weak, and rusty.

10,000 Cl_2O_5 and 20,000 N_2O_3. Tested for nitrite only. Red, weak.

Results show chlorate can be detected when mixed with a considerable excess of nitrite after destroying the latter with SO_2, but the nitrites cannot be detected by this method if chlorate is greatly in excess.

Nitrate and Chlorate.

N_2O_5 *in Equal and Excessive Proportion.*—The following mixtures were tested for chlorate only by adding 1 drop orcinol and 2 c.c. sulphuric acid as usual.

Equal volumes 40,000 N_2O_5 and 40,000 Cl_2O_5. Blue band distinct.

Equal volumes 10,000 N_2O_5 and 10,000 Cl_2O_5. Blue to rainbow band.

Equal volumes 5000 N_2O_5 and 10,000 Cl_2O_5. Blue soon changed to green.

Equal volumes 4000 N_2O_5 and 20,000 Cl_2O_5. Not satisfactory.

Therefore the chlorate will not be detected if nitrate is present in considerable excess.

Chlorate in Enormous Excess.—Equal volumes of 300 Cl_2O_5 and N_2O_5 60,000. The Cl_2O_5 is present in this mixture in the proportion of 200 to 1 N_2O_5, and the dilution of N_2O_5 is 120,000. It was tested for nitrate only. 4 tests were made and 4 comparative with 120,000 N_2O_5. Added to each 2 drops SO_2 and HCl. Set rest fifteen minutes, then added 2 drops orcinol and sulphuric as usual—pure nitrate bands in all; comparative test not to be distinguished from the others. Result shows, if nitrate is mixed with enormous excess of chlorate, the latter can be easily and completely destroyed by SO_2, while the nitrate remains unaffected and can be detected afterwards. This is the best method; yet I should observe, if the quantity of chlorate is not excessive, the nitrate can be detected with phenol and HCl without destroying the chlorate. Equal volume 10,000 N_2O_5 and 10,000 Cl_2O_5 gave excellent results. 1000 Cl_2O_5 and 5000 N_2O_5 fairly good by this method.

Nitrite, Nitrate, and Chlorate.

Mixed equal volumes of 10,000 N_2O_3, 10,000 N_2O_5, and 10,000 Cl_2O_5. Tested with phenol, red band; with 2 drops SO_2 and phenol, no band; nitrite destroyed, nitrate latent. Chlorate at this dilution gives no band with phenol in presence of SO_2. If much more chlorate were present a band (hardly characteristic) would be seen at this stage. The band has already been described (see Phenol and Chlorates). Tested with 1 drop SO_2 and 1 drop orcinol blue band only—chlorate. Tested again, adding 2 drops SO_2, 1 drop HCl, and allowing the test to stand fifteen minutes, then added copper and orcinol, beautiful orange bands at once; nitrite and chlorate destroyed by SO_2, bands due to nitrate.

Previous experiments have shown—

1. That the proportion of nitrite might be considerably increased without preventing the detection of chlorate, and very largely increased without interfering with detection of nitrate.
2. That the proportion of nitrate might be very greatly increased without interfering with the detection of nitrite, but could not be largely increased without preventing the detection of chlorate.
3. That the presence of much more chlorate would prevent detection of nitrite, but an enormous excess would not prevent detection of nitrate.

Colour Reactions Produced by Oxidising Agents free from Nitrogen, with Phenol and Orcinol.

The reactions with chlorates have been already described, those with ferricyanides, permanganates, chromic acid, and hydroxyl will now be given. If the solutions are strong they all produce intense brown or ruddy brown bands; it is only with weak solutions that bands possessed of any distinctive character are ever obtained. I have described these reactions merely to show that the bands are entirely different to those produced with nitrogen acids, and therefore that the presence of these oxidising agents should never lead to error in testing for nitrites and nitrates. 0·5 c.c. solution of the oxidising agent for each test, 1 drop phenol to this or 1 drop orcinol.

Potassic Ferricyanide.

A strong solution turns brown with sulphuric acid alone; a weaker not so affected by the acid, gave brown band with phenol and faint yellow turning brown with orcinol.

Potassic Permanganate.
N/10 diluted with 4 volumes of water.

Phenol.—Broad, turbid, light ruddy brown band. With HCl, pale yellow broad upper band; narrow lower ruddy band, changing on standing to light vermillion.

Orcinol.—Compound band, ruddy top, dull green below. With HCl, compound band, dull orange top, emerald green below.

If 2 drops SO_2 added before anything else, no band on adding the other reagents.

Potassic Dichromate.
Half grm. in 1 litre of water.

Phenol.—With or without HCl, brown band soon gets lighter.

Orcinol.—With or without HCl, rainbow band, colours not brilliant.

If 2 drops SO_2 added before anything else, no band on adding the other reagents. This distinguishes chromates from chlorates; if both are present blue band appears, although SO_2 was used. This due to chlorate *only*, the chromic acid having been reduced.

Hydroxyl.

About 3 volumes strength diluted with 20 volumes water.

Phenol.—Compound band, ruddy top, and dull green below. With HCl, very faint purple, changing to pink.

Orcinol.—Sharp ruddy band on standing changes to compound band, dull orange top, olive green below. With HCl, purple top band, lower band as above but weaker; if SO_2 used no bands.

Remarks and Conclusion.

It has been clearly shown that orcinol is very superior to phenol as a test for either nitrites or nitrates; it is far more delicate even without copper, the bands are very permanent, while those with phenol are not, and it will detect nitrates in the presence of bodies that would interfere with the phenol reaction, *e.g.*, a large quantity of HCl or chlorides, iron in the state of ferrous salt. It is true phenol gives a rather finer band in presence of much ferric iron, but if the experiment is repeated with addition of SO_2 the orcinol band becomes normal, whereas the phenol band may disappear completely. This should be noted, as it might lead to the erroneous conclusion that the band was originally due to nitrite.

As regards carbolic acid, the following passage occurs in "Fresenius's Qualitative Analysis," Ninth English Edition, p. 208. "Of the reactions which have been given to effect the detection of nitric acid, those with sulphate of protoxide of iron and sulphuric acid, with copper filings and sulphuric acid, with carbolic acid, and also those based upon reduction to nitrites, give the most positive results."

Now this statement as regards the reliability of carbolic acid is contradicted in the Tenth Edition, p. 234, in the following sentence:—"Chloric acid behaves like nitric acid with brucine, diphenylamine, paratoluidine, and phenol, or at all events the reactions are so similar that the two acids cannot be distinguished with certainty by these reagents."

This may be true if the phenol test is applied to a dry residue or strong solution, but, it is hardly necessary to add, is certainly *not* true if the experiment is made with a sufficiently dilute solution, as pointed out in this paper.

It is evident that phenol and orcinol (particularly the latter) are of great value as reagents for the detection of nitric acid; they will also be found, under certain conditions, very convenient for nitrites, especially in the absence of Griess's or Meldola's reagents.

It is not, however, pretended that they are at all equal for this purpose to those exceedingly delicate and characteristic tests for nitrous acid.

Notes.

Orcinol.

It would appear that dealers in reagents only recognise this phenol by the old name orcin, for on sending an order for orcinol to one of the largest drug houses in London I was informed that the article was unknown, but orcin could be supplied. I had to wait several months in consequence before obtaining it, and was obliged to work in the meantime with a very old sample, which had been in my possession fifteen years. It was highly coloured, but rather more sensitive as a reagent for nitrites and nitrates than the fresh sample (almost colourless) with which the work here recorded has been done. There was this marked difference: the old sample gave a pronounced orange band with nitrites or nitrates and HCl, even at the highest dilutions, whereas the new has always given at these dilutions pink or orange-pink bands. This new sample is in good crystals and seems to be pure, but it is possible other samples in the market may react somewhat differently to the one I have used. The absolute purity of any of them is perhaps open to doubt.

Copper Orcinol Reagent.

a. Take 25 c.c. 2 per cent solution pure copper sulphate (crystals), add 1 c.c. pure sulphuric acid, stir well, and after a few minutes add 25 c.c. pure 15 per cent HCl. Dissolve 2·5 grms. orcinol in this mixture and filter.

b. Dissolve 2·5 grms. orcinol in 50 c.c. distilled water, add 8 grms. potassic chloride, 0·5 grm. copper sulphate (at once), 1 c.c. sulphuric acid (all pure); when dissolved, filter.

a is a little more sensitive than *b*, but the latter may possibly keep better. How long either can be kept fit for use has not yet been ascertained. They should be preserved in glass stoppered bottles away from the light.

The reagent is exceedingly convenient for the detection of either nitrites or nitrates, but is *not* suitable for chlorates. Add 2 drops to 0·5 c.c. of the solution to be tested and run in 2 c.c. sulphuric acid. If reaction (as described) occurs in the presence of SO_2, this, of course, indicates nitrates.

α-Naphthol.

It has been shown this phenol is not available as a test with sulphuric acid for nitrites or nitrates; it can, however, be used for the detection of the former by adding 2 or three drops of the alcoholic solution to, say, 10 c.c. of the aqueous solution of nitrite in a test-tube, then one or two drops of 1 to 1 sulphuric acid. If the quantity of N_2O_3 is one in a million a pale greenish yellow colour is seen after a few minutes, best observed at this dilution by looking down the tube on a white surface; with much stronger solutions a precipitate occurs, and the colour of the fluid may approach orange. The reaction seems quite characteristic of nitrous acid.

Tube Rack.

The racks in ordinary use were found inconvenient for this work; the wooden draining pegs are apt to soil the tubes after they have been carefully cleaned and rinsed with distilled water. Draining pegs are dispensed with in the rack I have contrived; the inverted tubes rest on a glass rod, and a centre slide has been provided, which is indispensable. Messrs. Townson and Mercer, London, have been furnished with a pattern of my rack, and will no doubt supply similar ones if required.

Drop Tubes.

Drop tubes very suitable for delivering the reagents are made of short pieces of strong ¼-inch tube drawn to a thick blunt point with small orifice; a short piece of black rubber tubing is placed over the free end and closed at the other extremity with a short piece of glass rod.

Falmouth, Jamaica, B.W.I.,
May 12, 1888.

THE RELATIVE VALUES OF THE WEIGHTS OF HYDROGEN AND OXYGEN.*

By JOSIAH PARSONS COOKE and THEODORE WILLIAM RICHARDS.

(Concluded from p. 20).

Apparatus for Preparing Hydrogen.

In the preliminary determinations, the hydrogen was drawn from a large copper generator charged with zinc and dilute sulphuric acid. The zinc and sulphuric acid was wholly free from arsenic, and of the best quality, but not absolutely pure; and the writer depended upon an elaborate system of washers and driers for purifying and drying the gas. He found the greatest difficulty in removing the last traces of sulphurous oxide, which hydrogen prepared in this way always carries. The presence of this trace cannot be detected by litmus-paper, but is immediately indicated by the production of hydric sulphide when the gas is passed over heated platinum sponge; and by interposing a tube containing platinum sponge maintained at a low red heat, followed by a set of potash bulbs, this impurity can be entirely removed. It can also be removed by washing with a strong solution of potassic hydrate alone, if the gas remains long enough in contact with the solution. It was found, however, that a series of potash bulbs was insufficient for this purpose; but two of the long washers represented in the background of Fig. 5 and Figs. 7 and 8 (*ante*), where the gas in small bubbles travels up a tube 5½ feet long, are sufficient to remove the sulphurous oxide from even a quite rapid current of hydrogen gas. A series of preliminary determinations was made with hydrogen gas thus prepared and purified, and it was obvious from an inspection of the results, as well as from the difficulties which were experienced in keeping all the joints of this complicated apparatus tight, that the irregularities arose from the diffusion of the air into the hydrogen at some one or other of these joints. It was therefore next sought to simplify the apparatus, and to depend upon the purity of the materials rather than on the completeness of purifying methods for obtaining pure hydrogen. Meanwhile, for reasons stated below, the writer had reduced very materially the scale of his operations, and this rendered unnecessary the large generator we had first employed.

The second apparatus that was constructed is represented in Fig. 5 (*ante*). Of this, the generator, in which hydrogen is made from pure zinc and hydrochloric acid, is the same as that described by Julius Thomsen.† The Wolff bottle is filled with pure granulated zinc, and the upper bottle contains pure hydrochloric acid diluted about one half. By means of a glass stopcock the acid is allowed to flow into the zinc drop by drop, and in this way the current of hydrogen can be quite closely regulated. Tubes protected by stopcocks are provided for adding fresh charges of acid, and for drawing off the solution of zinc chloride; also a tube connecting the upper part of the two bottles enables the operator to effect these transfers without introducing any air. The gas from this generator passed first through a long potash tube inclined at about 10° to the horizon, then through a tube about three feet long filled with calcic chloride, then through a glass tower filled with glass beads drenched with sulphuric acid, and lastly through a second tower filled with phosphoric pentoxide. As many of the joints as possible were made by fusing together the glass, and all the others were protected by a cement consisting of equal parts of pitch and gutta-percha. It will be noticed that an overflow is provided at the point where the potash tube connects with the calcic chloride tube, the open mouth of the overflow tube dipping about six or eight inches deep under concentrated sulphuric acid. This overflow indicated the least change of tension of the hydrogen in the apparatus, and would have shown the least leak if it had existed; but the apparatus as thus constructed remained absolutely tight so long as it was in use.

With the hydrogen drawn from this apparatus the first determinations were not wholly satisfactory, and the cause of error was traced to the air dissolved in the dilute hydrochloric acid with which the generator was charged. In all the succeeding determinations the greatest pains were taken to remove the last traces of air by boiling the dilute acid, and allowing it to cool in a stream of hydrogen; and as additional precaution, while the solution was still warm, the gas was exhausted from the containing vessel and pure hydrogen run in, several times in succession, the pure acid being finally conveyed into the generator entirely out of contact with the air. The need of all these precautions will be seen when it is considered how small an admixture of air or of nitrogen will materially influence the weight of the hydrogen. If only one ten-thousandth of the volume of the hydrogen were replaced by air during the process of filling the globe, this would cause an apparent increase of weight in the hydrogen of five-tenths of a milligrm., and that, other things being equal, would reduce the atomic weight of oxygen two-hundredths of a unit.

The precautions used in filling the globe have already been described in detail, and with hydrogen from the apparatus, constructed and charged as just described, were made the five consecutive determinations whose results are given as of the first series in the "Table of Final Results" (p. 32). These and all the determinations given in the Table were made by the writer's pupil and assistant, Mr. Theodore William Richards, to whose experimental skill the success of the investigation is largely due, and without whose assistance the work could not have been completed in the present condition of the writer's sight. The mean of these first five results, as will be noticed, is but little less than that obtained by Dumas, and the probable error, $\pm 0{\cdot}0048$, is considerably less than that of Dumas. In order to understand how this result appeared to the writer, it must be remembered that he started with a certain prepossession in favour of the hypothesis of Prout, based on his previous work on antimony; and, furthermore, that the effect of the causes of error which had been encountered and overcome all tended to lower the atomic weight; and the result obtained was a maximum which had been reached after every known precaution had been taken. But although this maximum was essentially the same as that obtained by Dumas by an obviously less direct and less accurate method, yet it was still possible that there might be some constant error, and that some cause might yet be found which would raise the maximum by the forty-six thousandths required to give the whole number 16. It was true that the probable error was only about one-tenth of this difference; still, as the materials had been purified, the maximum had constantly risen, and the theoretical limit was in sight. In reviewing the work it was obvious that the degree of accuracy of the methods used for determining the weights both of the hydrogen and of the water was so great that no possible error in these values could account for the difference in question. This would imply an error of 1·2 milligrms. in the weight of the hydrogen, and of 10·8 milligrms. in the weight of the water, and the possible error of a single determination—leaving out of account the reduced probable error of the average value—was far within these limits. If there was a constant error, it must result from the want of purity of the hydrogen gas, and we therefore determined to try another method for preparing the hydrogen.

The apparatus next used is represented in Fig. 7 (*ante*), and differs from the last only in the generator. Here the generator is a three-necked bottle having a capacity of about two litres, filled to about one-eighth of its capacity with a semi-fluid amalgam of mercury and pure zinc. On this rests dilute hydrochloric acid, containing about 20

* Contributions from the Chemical Laboratory of Harvard College. From the *Proceedings of the American Academy of Arts and Sciences*, vol. xxxiii.

† Thermochem. Untersuch., vol. i., p. 28.

per cent of HCl, nearly filling the bottle. Into this acid dips a platinum electrode, while a straight glass tube, passing through the middle neck and dipping under the amalgam, gives the means of establishing an electrical connection between the large platinum plate which forms the negative electrode and the amalgam. In addition, a syphon tube for drawing off the acid when saturated with zinc, a funnel tube for introducing a fresh charge, and an exit tube, all well cemented to the several necks of the bottle, complete the generator. When the electrical connection is broken all chemical action ceases, but on connecting by a wire the platinum electrode with the amalgam, a very steady but slow evolution of hydrogen gas takes place, which can be regulated with the greatest nicety by varying the resistance of the connecting wire. On interposing two cells of a Bunsen battery the evolution of gas becomes very rapid. Besides its special use in this connection, the apparatus will be found of great value, as giving an absolutely constant source of pure hydrogen, whenever required. In charging the generator with acid, the same care was taken to exclude every trace of air as with the previous apparatus, and with hydrogen thus prepared a second series of five consecutive determinations were made, whose results are given in the Table on p. 32 below those of the first series; it will be noticed that, while the average value obtained is essentially identical with the previous result, the agreement of the several determinations is more close, and, in consequence, the probable error is reduced more than one-half. A closer agreement under the circumstances could not possibly be expected.

Such a striking confirmation of the previous result seemed very conclusive, and the very small probable error indicated a command of the method which was very satisfactory. Still it could not be proved that there might not be a constant impurity in the hydrogen used. As the hydrogen had passed every possible chemical test unimpeached, the only possible impurity that could be suspected was nitrogen, and Mr. Richards therefore made a careful spectroscopic examination, searching for the more conspicuous nitrogen lines in the spectrum obtained by passing an induction current through a rarefied atmosphere of the gas from the generator just described; but not the faintest trace of any of these lines could be seen.

Still, as in the electrolytic method of preparing the hydrogen the same materials, hydrochloric acid and zinc, were used as in the first series of experiments, it was determined to procure hydrogen by a wholly different chemical process, using the well-known reaction of metallic aluminum upon a solution of potassic hydrate.

The purest aluminum sheet that could be obtained in the American market was procured for the purpose, and the apparatus represented in Fig. 8 (*ante*) was used for generating the gas. The generator here was a simple flask holding a strong solution of chemically pure potassic hydrate, and the aluminum was introduced in small pieces through a large open tube—dipping under the surface of the solution—the liquid being maintained at a level near the open mouth of the tube by the tension in the interior of the apparatus. The small strips of aluminum were carefully cleaned, and caused slowly to slide down the tube; the evolution of hydrogen from the surface began as soon as the strips of metal touched the liquid, and became very active in the tube before they dropped into the flask. And this action insured the removal of any traces of air which might adhere to the surface. In this apparatus the long caustic potash washer was not used, as being no longer necessary, and the gas was passed through caustic potash bulbs to remove the spray, and then through a calcic chloride tube, and over sulphuric acid and phosphoric pentoxide as before.

With hydrogen thus prepared, the six determinations of the third series in the Table were made; and it will be seen that the average of the results is a value which is essentially identical with the average values from the other two series. The probable error in this last series is larger than in the second, although still very small; but the difference is due, as the note-books plainly show, to the different conditions under which the two series were made. As before stated, the compensation of the balance was perfect, and the apparent weight of the globe did not alter by a tenth of a milligrm., even with wide variations of temperature and pressure, so soon as those changes became constant. But when the changes of temperature in the balance-room were rapid, currents of air were established in the case, however great care was taken in protecting it, which rendered the apparent weight irregular to the extent of one- or two-tenths of a milligrm.; and the third series was made under less favourable conditions in this respect than the second. This point is illustrated by the following notes of two determinations which are given in full, in order that all the circumstances connected with the determinations may be seen.

Series II. *Determination 5.*

Weighings of the globe:—

				Grms.
Exhausted.	June 6th,	6.00 p.m.	Tare	=0·1960
	,, 7th,	7.25 a.m.	,,	=0·2011
	,, ,,	8.30 a.m.	,,	=0·2011
	,, ,,	11.20 a.m.	,,	=0·2011
	,, ,,	2.00 p.m.	,,	=0·2011
				0·2011
Filled with hydrogen.	June 7th,	7.20 p.m.	Tare	=0·6100
	,, 8th,	8.00 a.m.	,,	=0·6156
	,, ,,	10.00 a.m.	,,	=0·6156
	,, ,,	12.15 p.m.	,,	=0·6154
	,, ,,	7.50 a.m.	,,	=0·6155
	,, ,,	9.30 a.m.	,,	=0·6155
	,, ,,	11.40 a.m.	,,	=0·6155
				0·6155

Weight of hydrogen taken = 0·6155 − 0·2011 = 0·4144 grm.

The combustion was started at 11 a.m., and stopped at 6 p.m.

Weight of P_2O_5 tube—

Before combustion	=48·2499	h=29·58	t=26·0
After ,,	=48·2529	h=29·76	t=23·5
Gain in weight	= 0·0030	+0·18	−2·5

Weight of H_2SO_4 tube—

Before combustion	=62·3959	h=29·58	t=26·5
After ,,	=66·1076	h=29·75	t=23·5
Gain in weight	= 3·7117	+0·17	−3·0

The correction to vacuum for 3·7117 grms. of water weighed with brass and platinum weights is 4·1 m.g.

	Grms.
Gain in weight of H_2SO_4	3·7117
,, ,, P_2O_5	0·0030
Correction to vacuum	0·0041
,, for t and h P_2O_5	0·0004
,, ,, ,, H_2SO_4.. ..	0·0005
Total H_2O formed	3·7197
Weight H taken	0·4144
Weight O combined..	3·3053

$$\text{Atomic weight of oxygen} = \frac{2 \times 3{\cdot}3053}{0{\cdot}4144} = 15{\cdot}953 \text{ grms.}$$

P.c. H in water = 1·140. P.c. O in water = 88·860

Series III. *Determination* 5.

Weighings of the globe:—

			Grms.
Exhausted.	Nov. 8th, 7.45 a.m.	Tare	=0·1127
	,, ,, 11.10 a.m.	,,	=0·1125
	,, ,, 12.00 m.	,,	=0·1122
	,, ,, 5.00 p.m.	,,	=0·1122
	,, 9th, 8.40 a.m.	,,	=0·1121
	,, ,, 9.15 a.m.	,,	=0·1119
	,, ,, 12.40 p.m.	,,	=0·1120
	,, ,, 4.00 p.m.	,,	=0·1121
	,, 10th, 8.40 a.m.	,,	=0·1119
	,, ,, 10.40 a.m.	,,	=0·1120
	,, 11th, 8.40 a.m.	,,	=0·1121
	,, ,, 10.15 a.m.	,,	=0·1120
	Average ..	,,	=0·1120
Filled with hydrogen.	Nov. 11th, 12.45 p.m.	Tare	=0·5325
	,, ,, 4.00 p.m.	,,	=0·5348
	,, ,, 6.00 p.m.	,,	=0·5328
	,, 12th, 12.00 m.	,,	=0·5273
	,, 14th, 8.00 a.m.	,,	=0·5273
	,, ,, 9·30 a.m.	,,	=0·5273
	,, ,, 11.15 a.m.	,,	=0·5273
	Tare filled with H ..		=0·5273
	,, empty..		=0·1120
	Weight H		=0·4153

The combustion was started at 11.25 a.m., and stopped at 6 p.m.

Weight of P_2O_5 tube—

Before combustion	=48·1795	h=30·03	t=16·5
After ,,	=48·1832	h=30·00	t=18·0
Gain in weight	= 0·0037	− 0·03	+ 1·5

Weight of H_2SO_4 tube—

Before combustion	=64·9625	h=30·03	t=16·5
After ,,	=67·6832	h=30·00	t=18·0
Gain in weight	= 3·7207	− 0·03	+ 1·5

	Grms.
Gain in weight of H_2SO_4	3·7207
,, ,, P_2O_5	0·0037
Correction to vacuum	0·0041
	3·7285
Correction for t and h, H_2SO_4 ..	−0·0002
,, ,, ,, P_2O_5	−0·0002
Total H_2O formed	3·7281
Weight H taken	0·4153
Weight O combined..	3·3128

$$\text{Atomic weight of oxygen} = \frac{2 \times 3{\cdot}3128}{0{\cdot}4153} = 15{\cdot}954 \text{ grms.}$$

P.c. H=11·139 P.c. O=88·861

On examining the Table, it will be noticed that the mean of the determination by the electrolytic method is the mean of all the determinations combined, and that the probable error of the total average is only about one-fourth as great as the error of the nineteen determinations of Dumas, which are incomparably the best that have hitherto been made.

It does not now seem possible to escape from the conclusion, that the proportions in which the purest hydrogen that can be made combines with oxygen to form water are those of 2 to 15·953, with a possible error far within the $\frac{1}{100}$ of a single unit.

The question, of course, still remains, is the hydrogen thus prepared the typical hydrogen element? But this is the same question which must arise in regard to any one of the elementary substances; and all that we can say is that the evidence in regard to the purity of the hydrogen we have used is as good as any that can be adduced in regard to any one of the elementary substances whose atomic weight has been most accurately determined. The question as regards Prout's hypothesis narrows itself now to this one point; and here we must be content to leave it until further investigation has given us more knowledge in regard to the nature of elementary substances.

Atomic Weight of Oxygen.

Table of Final Results.

Series I.

Weight of Hydrogen.	Weight of Water.	Atomic Weight of Oxygen.
0·4233	3·8048	15·977
0·4136	3·7094	15·937
0·4213	3·7834	15·960
0·4163	3·7345	15·941
0·4131	3·7085	15·954

Average = 15·954 ± 0·0048

Series II.

0·4112	3·6930	15·962
0·4089	3·6709	15·955
0·4261	3·8253	15·955
0·4197	3·7651	15·942
0·4144	3·7197	15·953

Average = 15·953 ± 0·0022

Series III.

0·42205	3·7865	15·943
0·4284	3·8436	15·944
0·4205	3·7776	15·967
0·43205	3·8748	15·937
0·4153	3·7281	15·954
0·4167	3·7435	15·967

Average = 15·952 ± 0·0035

Total average = 15·953 ± 0·0017

Dumas's value = 15·960 ± 0·0070

The writer at first planned to carry out the investigation on a much larger scale, and for the purpose had blown a globe similar to that represented by Fig. 1, but of five times the capacity, and counterpoised it by the same general method. This globe held twenty-five litres (somewhat over two grms. of hydrogen gas), or five times as much as the globe actually used; but the difficulties of carrying out the determinations on this scale led him to reduce the scale of the determinations to that actually adopted; and in the view of the results finally reached, it is evident that no appreciable advantage would have been gained from the enormous expenditure of time and labour which the process on a large scale involves. Assuming that the difficulties of preparing pure hydrogen gas on that scale could have been overcome, it would have required from five to seven hours to fill the globe, and four or five days continuously to complete the combustion.

Moreover, after many trials, the writer could not procure a globe that would stand the requisite pressure weighing less than two and one-half kilogrms., and with this weight and volume it was not possible, with the best balance he could command, to distinguish half a milligrm. with as much accuracy as he could one-tenth of a milligrm. with the smaller apparatus, while a vastly longer time was required to reach equilibrium. A great deal of time was spent in endeavouring to perfect this larger apparatus, and a very thorough knowledge was acquired of its relative efficiency. The greatest gain that could have been expected in carrying out the work on this scale

would have been the reduction of the probable error to about one half of the present amount, but it is obvious that this gain could be of no importance in the present condition of the science. The accuracy we have reached is far beyond the demands of any analytical work; and, as we have shown, the theoretical question in regard to Prout's law has been settled so far as analytical work can solve the problem. It now turns solely on the typical character of the material we call hydrogen, when prepared in the purest condition known to modern science.

In considering the bearing of the result now published on Prout's hypothesis, it must be borne in mind that it confirms in a most striking manner the result of Dumas, based on the weight of oxygen which water contains, and in connection with his results furnishes a complete analysis of water with a degree of accuracy as great as can be expected, or as has ever been obtained, in any analytical work.

Complete Analysis of Water.

Percentage of oxygen after Dumas ..	88·864 ± 0·0044
Percentage of hydrogen according to the present work	11·140 ± 0·0011
	100·004 ± 0·0045

It must be remembered that in Dumas's investigation the oxygen alone was weighed, while in the present investigation the hydrogen alone was weighed, and the fact that these two wholly independent analytical results made under such widely different circumstances, exactly supplement each other within the limits of probable error, is an evidence of accuracy and a proof of finality which is irresistible.

It would have been highly desirable, if it had been possible, to determine both the oxygen and the hydrogen in one and the same analytical process, as the writer succeeded in doing in the case of silver, bromine, and antimony, and he made many experiments on the reduction of oxide of silver by hydrogen with this view. He succeeded in preparing pure oxide of silver of definite composition, but the investigation was interrupted by the failure of his sight before he was able to overcome the grave experimental difficulties which the process presented. In view, however, of the present results, it is doubtful whether any advantage would have been gained by that mode of experimenting, for no more certain confirmation could have been reached than that furnished by a comparison of Dumas's results with those of this paper.

Since this investigation was essentially finished, and the results communicated to the American Academy at their meeting of June 15, 1887, we have received from the author a "Sonderabdruck" from the *Berichte der Deutschen Chemischen Gesellschaft*, dated the 26th of July following, and entitled: "E. H. Keiser: Ueber die Verbrennung Abgewogener Mengen von Wasserstoff und über das Atomgewicht des Sauerstoffs." In this paper Mr. Keiser distinctly recognises the importance of directly weighing the hydrogen in the determination of the atomic weight of oxygen, and quotes the remarks of Dumas given above. He has also devised a very ingenious method of weighing hydrogen when occluded by palladium; but the preliminary results he publishes are far from having the degree of accuracy required, and lead us to infer that, like our own preliminary results, they must be vitiated by varying impurities in the hydrogen gas used. The three determinations whose results he publishes gave for the atomic weight of oxygen, respectively, 15·873, 15·897, and 15·826.

We are sorry if Mr. Keiser has entered on somewhat the same field which we have so long occupied, without knowledge of our work. But, as above stated, our investigation was begun more than five years ago; and the methods employed have been freely explained to the many chemists, both American and European, who have visited Cambridge during the interval. We earnestly hope that Mr. Keiser will carry out his investigation; for so important a constant as the atomic weight of oxygen cannot be too often verified.

POISONS AND POISONING.*

By C. MEYMOTT TIDY, M.B., M.S., &c.,
Professor of Chemistry and of Forensic Medicine at the London Hospital, &c.

Toxicology is the science of "poisons and poisoning." How comes "toxicology" to mean "the science of posions"? The Greek ward τόξον (derived perhaps from τυγχάνω) signified primarily that specially oriental weapon which we call "a bow." In the very earliest authors, however, it included within its meaning "the arrow shot from the bow."

In the first century A.D., in the reign of Nero (a poisoner and a cremationist), Dioscorides, a Greek writer on Materia Medica, uses the expression τὸ τοξικόν to signify "the poison *for smearing arrows with*." Thus by giving an enlarged sense to the word—for words ever strive to keep pace, if possible, with the scientific progress—we get our modern and significant expression "Toxicology," the science of poisons and poisoning.

And there, in that little piece of philology (τόξον and τοξικόν—a bow and a poison), you have not only the derivation of the word, but the early history of my subject.

A certain grim historical interest gathers around the story of poisons and poisoning. It is a history worth studying, for poisons have played their part in history.

The "subtil serpent" taught men the power of a poisoned fang. History presents poisoning in its *first* aspect in a far less repulsive form than it has assumed in latter days—(for a world may grow wiser and wickeder withal). Poison was in the first instance a simple instrument of "open warfare." For this purpose our savage ancestors tipped their arrows with poison in order that they might inflict certain death on a hostile foe. It can scarcely be questioned that the poison of the snake was the first material employed for this object. The use of vegetable extracts (such as *curarine*, the active principle of which is strychnine, and is employed at the present time by certain uncivilised conmunities) belongs to a later period.

And so the first use of poison was for an "open fight." It was reserved for later times to mix the cup of kinship with a treacherous, diabolical venom!

"An open fight!" Is the suggestion (think you) too wild, supposing "war chemists" with their powders, their gun-cotton, and their explosives, never to have been invented, that nations would have turned for their "*instrumenta belli*" to toxicologists and their poisons. I claim, however (notwithstanding that in this we missed our chance), no more for my subject than its due, if I attempt to localise the very cradle-room of science as the laboratory of the toxicological worker.

Besides snake-poison, the use of animal fluids, either alone or mixed with snake-poison, with which to charge arrows, is pre-historic. Thus in old Greek legend we read how Hercules dipped his arrows in the gall of the Lernœan Hydra to render the wounds they inflicted incurable and mortal, and how at last Hercules himself was poisoned by his wife's present, the tunic of the Centaur Nessus stained with his poisonous blood, which she vainly hoped might restore her husband's affection, but which only procured for him the frightful agonies and tortures of which he died.

The use of putrid blood as a poisonous agent and the admixture of the snake-poison with blood constitutes a curious history, when regarded in connection with our present views on septicæmia. The toxic activity of putrid

* A Lecture delivered before the Royal Institution of Great Britain March 2, 1888.

animal fluids seems to have been recognised in very early times. And I suppose these early observations on the effects of putrid blood explain the view almost universally adopted, that blood itself was a poison. Thus the deaths of Psammentius, king of Egypt (as recorded by Herodotus), and of Themistocles (as recorded by Plutarch), were said to have been effected by the administration of bullock's blood. Even Blumenbach, so lately as the middle of the last century, persuaded one of his class (by way of settling the question) to drink seven ounces of warm bullock's blood. The young man (good as were his intentions) did not die a martyr to science.

The history of poisons and poisoning, the contents of the first chapter of which I have thus briefly indicated (viz., the toxicity of the snake-poison and of blood), down to the final chapter, which commences with the properties and reactions of arsenic, forms a tempting subject for my lecture to-night. The histories of Circe and Medea—of Livia Drusilla and Locusta—of Tiberius and Nero—of the Borgias—of Hieronyma Spara, Tofana, Catherine de Medicis, St. Croix, and a host of other worthies, have proved charming topics for the marvellous-monger. And it would not have been an unworthy subject to bare the truths underlying the stories of generations of story-tellers, obscured as they have become by the demand of ignorant sensationalism and the terrors of a mean superstition. But this is not the subject I have proposed to myself for the discourse to-night.

"What is a Poison?"

Two difficulties present themselves in answering this question :—

1. *The law has not defined a poison, notwithstanding that the law at times demands of science the definition of a poison.*

I know a case, for example, where a prisoner, indicted for the administration of a poison, escaped, because the scientific witness declined to say that the drug administered by the prisoner was a poison.

2. *The popular definition of a poison is far from being a sound, much less a scientific definition.* Generally speaking it comes to this, that "A poison is a drug that kills rapidly when administered in a small quantity."

The phrase "a small quantity" as regards weight, and the word "rapidly" as regards time, are as indefinite as the classical piece of chalk as regards size.

I define a poison as—

"Any substance which otherwise than by the agency of heat or electricity is capable of destroying life either by chemical action on the tissues of the living body, or by physiological action after absorption into the living system."

(A) It will be convenient to consider first, *What a poison is not.*

It is not an agent that destroys life by physical influences, such as heat and electricity.

It is not an agent that destroys life by any purely mechanical act (*e.g.*, pins are not poison, although fairly included in the phrase "destructive things").

It is not an agent that destroys life by the mere blocking out of that which is necessary to maintain life (*i.e.*, the action of a substance to be a poison must be more than mechanical).

This latter point requires further consideration :—

Both nitrogen and carbonic acid destroy life as certainly as they extinguish a burning taper. Yet nitrogen is not a poison, whilst carbonic acid is.

Nitrogen simply destroys life by blocking out oxygen. Given the presence of 20 per cent of oxygen, the 80 per cent of nitrogen possesses no toxic effect.

The carbonic acid, on the contrary, is specifically toxic. The admixture of 20 per cent or of 80 per cent of oxygen does not materially alter the case. Oxygen or no oxygen, CO_2 is a poison.

(B) Consider next, *What a poison is.*

It is an agent capable of destroying life.

The use of the phrase *deadly* poison, is surplusage. If a body be a poison, it is deadly; if it be not deadly, it is not a poison.

My definition limits the mechanism whereby the toxic effect is induced, to *chemical* and *physiological* actions. I am conscious that this definition suggests classification. Certain is it, that Nature hates classification as truly as she declines definitions.

Let us trace some of these mechanisms of toxic activity. I select three illustrations of poisons belonging to different classes.

(1) *Sulphuric Acid.*—If a person swallows *sulphuric acid*, the tissues with which the acid comes in contact are more or less charred; "more or less," that is, according to the strength of the acid and the time of contact.

Charred :—This implies a chemical act, dependent on the power of sulphuric acid to combine with water.

The portion of the body thus charred dies. We call this *molecular* death. (This does not imply that *the person* is dead. Health is disturbed. Health is derived from the old Saxon word "Wholth," signifying *entirety*. Health implies the perfect rhythmicity of the bodily functions. It is that condition expressed with charming simplicity by Suffolk folk, who describe being "quite well" by the phrase, "*they feel all over alike.*" The charring process (molecular death) has disturbed rhythmicity. Before long all the members suffer with the charred stomach. The death, localised in the first instance, becomes general, the death of the entire body, *i.e.* of the person, eventually taking place. We call that *somatic* death. This is poisoning by sulphuric acid. But the primary act of disturbance—the first interference with the rhythmicity of health—resulted from the chemical power of sulphuric acid to combine with water. It will be evident that the chemical action of a poison depends on the chemical relationships of that poison.

(2) *Carbonic Oxide.*—Carbonic oxide is a true poison. It is a gas that may often be seen burning with a blue flame on the top of a bright fire in the open fire-stove.

Its importance amongst poisonous bodies depends on the circumstance that it is evolved in many manufacturing operations (*e.g.* lime and brick kilns, iron blast-furnaces, copper-refining furnaces, &c.), and that it is always present in small quantity in coal-gas, constituting its true toxic constituent.

What, then, is the mechanism whereby carbonic oxide destroys life?—The active agent of the blood is its red colouring-matter (*Hæmoglobin*). To the chemist this substance abounds in wonder.

We have reason to believe that hæmoglobin is formed from the albumenoids, the synthesis of which albumenoids is limited to the vegetable. Essential as the albumenoids are to animal life, the animal is dependent for their formation on the synthetical processes taking place in the plant laboratory. The animal, however, can transmute one albumenoid into another, (*e.g.* he can change albumen into a peptone), whilst he can also form from them bodies of less complicated constitution (*e.g.* fat) :—in other words he can lower them in the scale. But, save with one exception, he cannot use them to effect higher synthetical formations. This single exception is hæmoglobin.

It is no matter for surprise that a body like hæmoglobin—one of the chief actors, so to speak, in the curious drama of life and living—which comes on the scene through a stage opening, of which we neither know construction nor whereabouts—should possess unique chemical properties and relationships. I shall only trouble you this evening with one of these relationships.

As a general rule, a substance that combines with oxygen with difficulty, parts from it with ease, and *vice versâ*. It is difficult to make gold combine with oxygen, but it is easy to decompose oxide of gold. Potassium easily combines with oxygen, but it required the genius of a Davy and the resources of the Royal Institution to separate potassium and oxygen.

In hæmoglobin, however, we have a substance that combines with and delivers up its oxygen (*i.e.* is oxidised and reduced) with almost equal facility under similar conditions. Upon this and other chemical characteristics of hæmoglobin—as the oxygen-receiver, the oxygen-carrier, the oxygen-deliverer, the carbonic acid-receiver, carrier, and deliverer—the act of living depends. In other words, life depends on *the integrity* of the hæmoglobin—on the rhythmicity of those chemical processes, in effecting which hæmoglobin is the primary worker.

With these facts before us, let us turn to the toxic action of carbonic oxide.

The hæmoglobin at once seizes upon and combines with the carbonic oxide, carbonic oxide-hæmoglobin being formed.

Two difficulties arise:—

1. The hæmoglobin, saturated with carbonic oxide, cannot combine with oxygen. Regarding hæmoglobin as a *common carrier*, the carriage is full.

2. The hæmoglobin, being saturated with carbonic oxide, cannot get rid of the carbonic oxide under the ordinary conditions of respiration and circulation. Again, regarding the hæmoglobin as a common carrier, the vehicle, full up, cannot be unloaded.

To put all this in scientific phraseology, carbonic oxide-hæmoglobin is a comparatively stable compound, being neither decomposed by the presence of an excess of oxygen (as in the lungs) nor by carbonic acid. What must happen? The man dies because the integrity of the hæmoglobin has been disturbed—because the normal sequence of its oxidation and reduction has been interrupted by the formation of carbonic oxide hæmoglobin.

We call the result of all these chemical actions and interferences, poisoning by carbonic oxide.

3. *Strychnine* (the poison derived from St. Ignatius's Bean).

How does strychnine act? We know sadly little about it—so little that we use the phrase "physiological action" to express our want of knowledge. But we know something.

A marked chemical characteristic of strychnine is its power to combine with oxygen when the oxygen is presented to it in a nascent form.

Note then the conditions. Strychnine is in the body. There is also present in the blood hæmoglobin loosely combined with oxygen, which oxygen the hæmoglobin is always ready to give up on first demand. We are able to trace this action, and to see that the period of the primary strychnine fit coincides with the reduction of the hæmoglobin.

Why (you ask) does that kill? I cannot tell you. It is the highest form of knowledge to see the limits of positive knowledge, and to make that the starting-point for fresh inquiry.

From what I have said, it will be evident that my object has been to trace toxic energy to the chemical action of poisons on living tissues or fluids. The phrase "physiological action" must not be understood as implying any theory *re modus operandi*. There is a danger lest the phrase "physiological action" should be employed, or regarded, as explanatory. It no more explains (be it remembered) the action of certain drugs on the living body than the word catalysis explains fermentation.

(To be continued).

Physiological Researches on an Organic Substance Hydrogenising Sulphur in the Cold.—J. de Rey-Pailhade.—The substance in question (philothion) is obtained from the yeast-cell. It exists in the white of fresh eggs and in the recent blood of sheep. Normal human urine does not contain it. This is the first instance of a compound extracted from a living organism which is capable of hydrogenising sulphur.—*Comptes Rendus*, Vol. cvii., No. 1.

NOTICES OF BOOKS.

Electricity for Public Schools and Colleges. By W. Larden, M.A. London: Longmans, Green, and Co.

Elementary works on electricity and its applications are multiplying in our midst. But the treatise before us presents certain features which should, in our opinion, secure for it a favourable reception. Though intended for use in public schools it is not pervaded by the haunting consciousness of examinations which the pupil must be made, at all hazards, to pass. The book is not "syllabus" ridden. The author's plan of referring the student to special text-books in all parts of the subject where an elementary knowledge of chemistry is required is commendable, as is also his determination to take a different course concerning such a knowledge of systems of units and of mechanical principles, since, as he very justly observes, it is far from easy for the student to collect from various sources just the kind of mechanical knowledge required for the present purpose.

Mr. Larden does not, like some writers who might be named, pass with unbecoming haste from a meagre consideration of general principles to the construction of the dynamo, and then make a neck-or-nothing leap to the telephone. Here, on the contrary, the author expands, though of course in a summary manner, the entire subject—the laws and the facts from which such laws are induced. On this reason we should recommend the present volume as a "first book" on electricity to anyone who hoped in the future to turn his attention, more or less, to electric or magnetic research. There is no attempt at enumerating and describing all the various batteries, dynamos, &c., which have been devised by inventors. Neither do we find any discussion on the questions of priority which spring up in electricity more, perhaps, than in other sciences, and which occasion great trouble in Courts of Law. Such considerations are obviously of no use to the student. Another commendable feature is that mathematical formulæ, though introduced where useful, are not employed where they might be dispensed with.

The bibliography which follows upon the preface, though the author admits its incompleteness, will prove exceedingly useful to pupils who wish to push their studies further in any department.

The arrangement of the work is as follows:—After stating the general phenomena of magnetism the author passes on to the mechanical and magnetic units, magnetic measurements, and terrestrial magnetism, the simpler phenomena of electrostatics, potentials, the elementary consideration of condensers, induction machines, atmospheric electricity, specific inductive capacities, electrostatic potential, the phenomena of currents and their accompanying phenomena, Ohm's law, the measurement of resistance and of electromotive force, Joule's law and the conservation of energy, galvanometers, action of currents on magnetic poles, selenoids, electro-magnets and diamagnetism, electro-magnetic induction, Ruhmkorff's coil, dynamo-machines, and various applications of electricity.

It will thus be seen that Mr. Larden gives a broad, comprehensive view of the science, whilst we think any careful reader will be satisfied with the expositions given.

The Retrospect of Medicine: being a Half-yearly Journal containing a Retrospective View of every Discovery and Practical Improvement in the Medical Sciences. Edited by James Braithwaite, M.D. (Lond.). Vol. xcvii., January—June, 1888. London: Simpkin and Marshall.

A very interesting paper in this issue is the one by Dr. G. Johnson on albuminuria as a result of sewage poisoning. The author gives four cases distinctly traceable to this cause, or, to speak more guardedly, cases where sewage poison must have been actually present, whilst, at the

same time, no other cause for the disease could be discovered. Dr. Johnson considers that sewage-poisoning is by no means an infrequent cause of blood-poisoning and consequent albuminuria, and that where it occurs the possibility of sewer-poisoning should always be borne in mind by the medical adviser. It is important to learn that the evil effects of sanitary neglect are not confined to epidemics of acute diseases.

Mr. Jonathan Hutchinson calls attention to the prolonged internal use of arsenic as a possible cause of cancer. Now the employment of arsenic as a cosmetic is recognised as an indisputable fact this danger should be brought under public notice.

It is further interesting to learn that "antipyrine," which is now becoming a fashionable panacea, is not without danger, even in the hands of experienced physicians. Dr. Jennings, of Paris, describes here certain cases of its alarming results.

Applications of Dynamics to Physics and Chemistry. By J. J. Thomson, M.A., F.R.S., Cavendish Professor of Experimental Physics, Cambridge. London: Macmillan and Co.

"Let none save mathematicians enter here" is said to have been the motto fixed up by a Greek philosopher of old over the entrance to his school. Professor Thomson might very fittingly have placed a similar caution on his title-page. To the majority of chemists this book will be purely unintelligible, and not a few physicists—we think Faraday, were he still alive, might be included—will fare but little better. We submit that an attempt might at least have been made to state definitely in language—and not merely in formulæ—what the author is aiming at and what results he has established.

The chemical subjects discussed are evaporation, the properties of dilute solutions, dissociation, the general case of chemical equilibrium, the effects produced by alterations in the physical conditions on the coefficient of chemical combination, the change of state from solid to liquid, and the connection between electromotive force and chemical change.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of emperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 1, July 2, 1888.

Application of Carnot's Principle to Endothermic Reactions.—M. Pellat.—The higher the temperature of a source of heat the further its spectrum extends on the ultra-violet side. We remark that certain indothermic reactions can be effected by very refrangible radiations, though they cannot be produced by the less refrangible radiations, though they cannot be produced by the less refrangible radiations because such may be emitted by sources of heat of a lower temperature.

Certain Compounds of the Cerite Metals.—M. Ouvrard.—The author seeks to obtain new salts of cerium, lanthanum, and didymium by acting upon the oxides of the metals with alkaline phosphates. The cerium oxide was completely freed from lanthanum and didymium by fusing the nitrates in ten times their weight of saltpetre. Lanthanum oxide, separated from didymium by Marignac's method, was free from cerium, and its concentrated nitric solution did not present the absorption-bands of didymium. After ignition in the air lanthanum oxide remained perfectly white. Cerium and lanthanum yield, by the reactions employed, products absolutely identical in crystalline form and chemical composition, differing merely in colour. The didymium oxide employed was free from lanthanum, but it had not been treated for the separation of other oxides which it might contain, such as samarium. Its equivalent was very close upon that given by M. Cléve for pure didymium (71). Didymium behaves with the potassium phosphates like those of cerium and lanthanum, giving under approximate conditions either tribasic didymium phosphate or a double phosphate.

On Cuprous Chloride Hydrochlorate.—Paul Sabatier.—The writer admits the priority of M. Engel (*Comptes Rendus*, cvi., p. 273). He assigns, however, to this compound the formula $CuCl_2,2HCl,5H_2O$, whilst M. Engel regards the compound as $CuCl_2HCl,3H_2O$.

On Cobalt Chloride Hydrochlorate.—Paul Sabatier.—Cobalt chloride is precipitated from its saturated aqueous solution by the addition of hydrochloric acid. Inferior hydrates may be obtained, but when the proportion of acid increases more and more the solubility of the salt does not always decrease, but passes a minimum, like copper chloride. The author has not been able to determine the composition of the pulverulent pale blue hydrochlorate, which decomposes on drying, leaving the amethyst-coloured chloride.

Contribution to the Means proposed for the Sanitation of Towns.—P. Chastaing and E. Barillot.—The authors state that for the treatment of sewage, &c., two systems are in actual use:—(1) *Irrigation or purification by the soil and by cultivation*, a system having many partisans, applicable when immense surfaces are available, when the ground is suitable for this kind of treatment, and when the water to be purified is not highly charged with putrescible matter; (2) the *chemical processes*, much denounced for some years, though, in virtue of the improvements recently effected and still possible, they merit the greatest attention. The authors conclude from their experiments:—(1) That the purification of sewage by the chemical method has a real efficacy; (2) that it may be applied without interruption and without insalubrious emanations; (3) that the agricultural utilisation of the nitrogen, potash, and phosphoric acid of the sewage is easily realised by this method.

Bulletin de la Société Chimique de Paris. Vol. xlix., No. 8.

On the Iodophenols.—E. Noelting and Th. Strecker.—The authors have prepared the ortho-, meta-, and para-iodophenols in a state of purity, and furnish an account of their properties.

Action of Roasting upon Various Oxides and Salts of Manganese.—A. Gorgen.—The oxidation of anhydrous manganese monoxide in contact with air may be continued up to the dioxide or may be stopped at the terms $3MnO_2MnO$; $MnO_2,2MnO$; MnO_24MnO. The red oxides can in general be oxidised by roasting. Manganese sesquioxide obtained below 300° is capable of observing oxygen from the air, and may be converted into dioxide by roasting. The manganese salts capable of yielding monoxide when ignited in the absence of air produce, after roasting, various peroxides, according to the circumstances in each case.

On a New Oxy-acid of Sulphur.—M. Villiers.—By the action of sulphurous acid upon sodium hyposulphite the author obtains the sodium salt of a new acid, S_4O_8Na.

On Saccharomyces Ellipsoideus and its Industrial Applications in the Manufacture of a Wine from Barley.—George Jacquemin.—The ferment of wine which has been used in the author's experiments for eighteen months has presented the greatest stability, and constitutes a species of ferment perfectly distinct from beer-yeast.

Researches on the Sulphines. — G. Patein. — The author has obtained four sulphine iodides, and is now about studying the corresponding cyanides.

A Novel Process for Preparing Tetraphenyl-ethylene.—Pierre de Boissieu.—It has been previously shown that the bromo-derivatives of diphenyl-methane are partially decomposed on dry distillation. From the decomposition of mono-bromo-diphenyl-methane they have, in this manner, obtained tetraphenyl-ethylene.

Extraction of Lead from the Residues of the Production of Zinc.—Eugene Prost.—The residues can be mechanically separated into two classes: "fine cinder," containing from 15 to 22 per cent of lead, and "granules," which do not contain more than 10 per cent. Both contain silver to the extent of from 225 to 340 grms. per ton. The author has succeeded in extracting from 84 to 90 per cent of the lead present.

The Industrial Value of Thompson's Calorimeter. —M. Scheurer-Kestner.—The author shows that this instrument may furnish indications useful to practical men who merely wish for an approximate result. In experienced hands the maximum error does not reach 4 per cent.

The Spectroscopic Detection of Blood. — G. Linossier.—The author considers that even when the spectra of oxy-hæmoglobine and of reduced hæmoglobine have been observed it is prudent to look for a confirmation in the spectrum of reduced hæmatine, since we are not yet fully acquainted with the spectroscopic characters of the innumerable artificial colouring-matters which industry is daily creating.

Zeitschrift fur Analytische Chemie.
Vol. xxvii., Part 1.

The Quantity of Moisture which Remains in a Gas after Desiccation by Phosphorus Pentoxide.—E. W. Morley. — Dibbits has previously shown how much moisture remains unabsorbed by calcium chloride at different temperatures. Sulphuric acid leaves approximately ¼ m.grm. of moisture in 100 litres of air. The author finds that the proportion of moisture not absorbed by phosphorus pentoxide is only ¼ m.grm. in 1000 litres of gas.

Improvement in the Goldenberg Method for the Analysis of Materials containing Tartaric Acid.—Dr. N. v. Lorenz.—Fifteen grms. tartar or lees of wine (7·5 grms. tartrate of lime) are comminuted as finely as possible and mixed with 250 c.c. (or respectively 150 c.c.) of water and 6 grms. of dry potassium chlorate in a porcelain capsule, holding at least 700 c.c., and boiled for twenty minutes over an open fire, stirring well and replacing the water lost by evaporation. When cold, the entire contents of the capsule are rinsed into a flask holding 500 c.c. (respectively 250 c.c.), and filled up to the mark. After it has been well shaken up it is filtered through a dry folded filter into a dry glass; 100 c.c. of the filtrate are then evaporated in a porcelain capsule of the size above mentioned on the water-bath until saline matter is just on the point of being deposited. The contents of the capsule, while still warm, are mixed with 5 c.c. glacial acetic acid, stirred until all the carbonic acid is expelled, after the lapse of five minutes mixed with 100 c.c. absolute alcohol, and stirred for two minutes. After fifteen minutes it is filtered through a filter holding 50 c.c., using, in preference, the filter-pump. The capsule is then washed with absolute alcohol until the filter is filled with the rinsings, using about 50 c.c. of alcohol. The margin of the filter is then twice washed with absolute alcohol, using each time 25 c.c. and letting the liquid drain thoroughly away. The filter with its contents is then returned to the precipitation-capsule, covered with 200 c.c. of water, heated to a boil, and titrated as follows with soda-lye, which must not be stronger than 0·3-normal. The hot liquid is mixed with neutral tincture of litmus, and the lye is then let run in until the bright red becomes decidedly dark red. It is then boiled for five minutes until the margin of the liquid has lost its violet cast and become a dead blue. The lye consumed is calculated for 3 grms. of the original substance. The alkaline lye is standardised by means of a tartar obtained from Seignette's salt and hydrochloric acid after repeated crystallisation from hot water.

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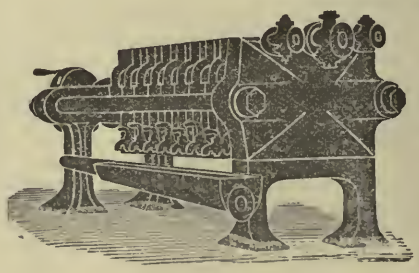

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NOTE ON THE

ACTION OF PETROLEUM ON LEAD.

By WILLIAM FOX.

When petroleum is stored in lead-lined tanks the lead is rapidly corroded, a heavy brownish-coloured powder being formed. Tanks in constant use, built of concrete and lined with heavy sheet lead, used for the storage of petroleum, become worn out in about three years owing to this corrosion. On analysis the powder from one of these storage tanks was found to consist of carbonate and hydrated oxide of lead and a small quantity of valerate of lead; the brownish colour was due to organic matter.

It appears probable that the white lead, of which the powder practically consists, and a paraffin, is formed by the action of an oxidising agent and a small quantity of valeric acid present in the petroleum on the lead, which may be expressed by the formula:—

$$2\begin{vmatrix} C_4H \\ \\ COOH \end{vmatrix} + Pb_3O_4 = PbH_2O_2 + 2PbOCO_2 + \begin{vmatrix} C_4H_9 \\ \\ C_4H_9 \end{vmatrix}$$

a view supported by the following experiments:—

I. Petroleum free from acidity, sealed in a tube with lead and heated in the water-oven some time, formed oxide of lead, but no hydrated oxide or carbonate of lead, nor was any gas evolved.

II. Valeric acid, sealed in a tube with lead and oxygen and heated in the water-oven, gave a white compound which proved to be carbonate and hydrated oxide of lead; the oxygen was absorbed.

III. Petroleum free from acidity, sealed in a tube from which oxygen was carefully excluded, with a small quantity of valeric acid and lead, gave hydrated oxide and carbonate of lead.

Laboratory, 4, Great Tower Street, E.C.

NOTE ON

SOME NEW SALTS OF PHENYL-HYDRAZINE.

By W. H. RICHARDSON.

During some experiments made with the idea of throwing light on the constitution of the beta-naphthol-azo compounds I examined the behaviour of oxy-azo-naphthalene and its sulphonic acid towards phenyl-hydrazine. I found that the sulphonic acid (roccelline) reacts readily, a new well-characterised substance being formed. This new body I was at first inclined to regard as a hydrazide, assuming that Liebermann's formula for the azo-derivatives of beta-naphthol is a correct one. Later on I found, however, that most sulphonic acids of oxy-azo-compounds react with phenyl-hydrazine, and that the presence of the beta-naphthol rest is not essential to the production of these compounds. From their properties I am inclined to regard them as simply hydrazine salts of the respective sulphonic acids; they may, however, be molecular compounds, similar in constitution to the bisulphite compounds of the azo-dyes described by Spiegler.

The compound from roccelline may be described in detail.

It is obtained by adding an aqueous solution of phenyl-hydrazine hydrochloride to a solution of roccelline acidified with hydrochloric acid. On acidifying a solution of roccelline a brown flocculent precipitate of free oxy-azo-naphthalene sulphonic acid separates, and this, on adding the hydrazine, becomes scarlet and crystalline. The yield is quantitative.

For analysis the substance was crystallised from dilute alcohol.

Sulphur Estimation.

I. 0·180 grm. gave 0·0905 grm. $BaSO_4$.
II. 0·231 „ „ 0·112 „ „

	I.	II.
S	6·8 per cent	6·6 per cent

Calculated for a molecular compound or a salt of phenyl-hydrazine and oxy-azo-naphthalene sulphonic acid, S 6·5 per cent.

The numbers above do not suffice to determine whether the compound is a salt or a hydrazide, the latter giving 6·8 per cent of sulphur.

The preparation of metallic salts by double decomposition has, however, rendered the assumption that the compound is a salt very probable. The barium, calcium, and magnesium salts were prepared, and found qualitatively to contain no hydrazine. In addition to this the barium salt was prepared by different methods, and barium estimations made. The numbers obtained show that the salt is oxy-azo-naphthalene sulphonate of barium and not the barium salt of a hydrazide.

I. Barium salt obtained by precipitation of a dilute alcoholic solution of the re-crystallised substance with barium chloride.

II. Barium salt obtained from the aqueous solution of the re-crystallised substance.

III. Barium salt from an aqueous solution of the product.

	I.	II.	III.
Barium found	14·95	15·12	15·01

Calculated for oxy-azo-naphthalene-barium sulphonate, barium = 15·4 per cent, while the barium salt of a hydrazide would give 12·7 per cent barium.

The properties of the compound itself are not of great interest. It is easily decomposed by boiling dilute acids or alkalies. It is sparingly soluble in water, easily in alcohol or acetic acid.

The corresponding hydrazine salts of several other azo-dyes have been prepared, but do not require any detailed description.

Through an error I made some experiments with naphthol yellow S, supposing it to be an azo-dye, as the name my sample went under is the name usually ascribed to amido-azo-benzene sulphonic acid. I found, however, that in this case, also, phenyl-hydrazine forms a characteristic salt, which is sparingly soluble in boiling water and crystallising from that medium in pretty light brown needles.

The formation of this compound will perhaps serve as a method of distinguishing between naphthol yellow and other yellow dye-stuffs. A solution of 1 grm. of the dye in a litre of water gives a crystalline precipitate on adding phenyl-hydrazine hydrochloride dissolved in water after a few minutes. The formation of the precipitate may be hastened by scratching the sides of the vessel with a glass rod.

In order to determine the composition of the body a sulphur estimation was made. The result shows that the compound is a phenyl-hydrazine salt of dinitro-alpha-naphthol sulphonic acid of the formula—

$$C_{10}H_4 \begin{cases} /OH \\ -NO_2 \\ -NO_2 \\ \backslash SO_3H.C_6H_5N_2H_3 \end{cases}$$

	Calculated.	Found.
S	7·5 per cent	7·8 per cent.

I may say, in conclusion, that the roccelline and naphthol yellow S used in these experiments were converted

into barium salts, and barium estimations made, in order to make sure that the dye-stuffs were pure.

Southowram, Halifax,
July 5, 1888.

TESTS FOR NITROUS ACID BASED ON MODIFICATIONS OF THE SULPHANILIC ACID METHOD OF GRIESS.

By DAVID LINDO.

Of the tests for nitrous acid discovered by Griess, one depends on reaction between the acid and metaphenylenediamine; some of the phenols reacting with the acid under similar conditions yield coloured products, α-naphthol for example, as mentioned under the head of "Notes," in a former paper, and I have since found the colour becomes more intense if the solution is rendered alkaline some time after adding the other reagents. Orcinol, I observe, also gives a colour reaction, but it is deficient in delicacy. It does not appear that the number of really good tests for nitrites is likely to be greatly increased in this direction; the contrary, however, is the case when sulphanilic acid is introduced, which is one of the reagents used to produce Griess's wonderfully delicate reaction. The other, it is well known, is naphthylamine, and the reaction occurs in an acidulated solution, the proper medium when naphthylamine is employed.

It appears a most important modification of the sulphanilic method was introduced last year by Zambelli, but this only came under my notice quite recently through reference made to it in a paper by Professor P. F. Frankland, on a "Gasometric Method of Determining Nitrous Acid."* Frankland says:—"Zambelli adds to the solution containing the nitrite a drop of a saturated solution of sulphanilic acid, then a drop of an aqueous solution of phenol, the mixture being then rendered alkaline with ammonia; the presence of nitrous acid is indicated by the appearance of a colouration, varying from faint yellow to intense reddish-yellow (like the colour of a strong solution of potassium dichromate), according to the quantity of the nitrous acid present."

When I met with this reference, having solutions of pure nitrite, carbolic acid, and several other phenols ready prepared, it naturally occurred to me to try all the phenols at hand in succession, which was done with the following results:—

Carbolic Acid.—Zambelli's observation confirmed.

Thymol.—Excellent reaction, stronger colour than carbolic gave at the same dilution of N_2O_3 (1,000,000), and inclined to orange.

Orcinol.—Reaction quite as good as with carbolic acid.

α-Naphthol.—Pink to red, according to strength of N_2O_3 solution.

I have since referred to abstract of Zambelli's paper, which appeared in the *Journal of the Chemical Society* last year, and find he employed α-naphthol and got the same result as I obtained with it. I used 1 per cent alcoholic solution of this phenol.

Previous to referring to the abstract, I had used a saturated aqueous solution of sulphanilic acid and 1 : 5 sulphuric. Zambelli dissolves the sulphanilic in dilute sulphuric, which of course is more convenient. I had found it indispensable to let the tests rest a few minutes after adding everything but the ammonia, before the latter was introduced, otherwise very little colour will be developed, even with pretty strong solution of nitrite. Zambelli, I observe, recommends an interval of ten minutes, which, at the temperature I worked at (about 28° C.) was found even more than sufficient. Provided the nitrous acid is allowed to act long enough on the sulphanilic, before adding the ammonia, it does not appear to matter whether the phenol is added immediately after the sulphanilic, or just before the ammonia.

These phenols give no colour reactions (or only feeble ones) with nitrous and sulphanilic acids in acid solutions. The prominent feature, therefore, in Zambelli's modification of the sulphanilic method is making the solution alkaline* after adding the other reagents, thereby rendering several phenols available as highly delicate and characteristic tests for nitrous acid, which would otherwise be of little or no value for the purpose. α-Naphthol, indeed, becomes a fairly good reagent when the solution is made alkaline, even without the intervention of sulphanilic acid; the colour, as already stated, is yellow, whereas, with the addition of sulphanilic, it is red. As regards orcinol, this of course is not a reliable agent at very high dilutions of N_2O_3, since solutions of this phenol, as it is very well known, gradually acquire colour on exposure to air in presence of alkalies, especially in the presence of ammonia.

The delicacy of the thymol reaction has been tested; comparative tests with carbolic acid were made at the same time.

Reagents.

Carbolic Acid.—10 per cent solution in dilute alcohol.

Thymol.—10 per cent alcoholic solution.

Sulphanilic Reagent.—1 : 5 sulphuric saturated with sulphanilic acid.

Ammonia.—6 to 7 per cent solution of ammonia.

Method.

Five c.c. nitrite solution taken for each test, ⅝-inch test-tubes employed. Three tests with each phenol made at each dilution of nitrite. Added to the solution to be tested, 1 drop of the sulphanilic reagent, and 1 drop phenol or thymol solution; let rest ten minutes, then added 1 c.c. ammonia, and mixed well.†

I have stated above that at 1,000,000 N_2O_3 the colour is deeper with thymol than with carbolic acid; with stronger solutions of nitrite, say 100,000 N_2O_3, the contrast is very great. There is this difference, however, between the colours which may cause phenol to be preferred for quantitative work. At 1,000,000 N_2O_3, and even before this dilution is reached, carbolic acid yields a bright pronounced yellow colour, whereas thymol—even at the highest dilutions of N_2O_3—gives a colour with a tinge of orange in it, never a definite yellow. The limit for both tests, *using five c.c. of nitrite solution*, seems to be about 1 N_2O_3 in 10,000,000 of water, the colours being very weak at this dilution.

The colours are fully developed immediately, or almost immediately, after adding the alkali,—a great point in favour of Zambelli's modification, especially when the method is used as a quantitative test. Another point in its favour is that the solutions are stable; Frankland has called attention to this, referring to carbolic acid: the same advantage attends the use of thymol.

I have only seen the abstract of Zambelli's paper. It is quite possible that in the original he has anticipated me in some of the observations I have made respecting the other phenols.

The Test Reversed.

These reactions can be made available for detecting very minute traces of the phenols in aqueous solution, but it will be seen at once they possess the defect in a high degree which is common to many of the tests already known, viz., that of not being characteristic. Carbolic acid and orcinol, it has been shown, give a yellow colour with the reagents at high dilutions, and no doubt there are several other phenols and allied bodies that will do the same. Thymol gives an orange even at high dilutions, but might easily be mistaken for a stronger solution of

* *Journal of the Chemical Society*, April, 1888.

* Pure fixed alkalines may be used, but ammonia is more convenient.

† Blank tests with distilled water and the reagents were of course made at the same time.

carbolic or orcinol. It is even doubtful if the red colour given by α-naphthol is peculiar to this phenol. Nevertheless, in consequence of their extreme delicacy, these reactions may under certain conditions prove of some value.

A mixture of pure nitrite solution (2000 N_2O_3) and the sulphanilic reagent, in equal volumes, was made, and allowed to stand a few minutes before it was used. This mixed reagent developed a yellow colour when ammonia was added to some of it in the undiluted state; but when 1 drop was mixed with 5 c.c. distilled water, and 1 c.c. of dilute ammonia added, no colour was observed. One part of carbolic acid in 1,000,000 parts of distilled water gave a very distinct yellow colour; with 1 drop of reagent and 1 c.c. ammonia, 5 c.c. of the phenol solution being used, α-naphthol at the same dilution—tested in the same way—gave a very distinct pink colour. This is certainly, as far as I am aware, a much smaller proportion of carbolic acid than any test on record is capable of detecting; but on the other hand, even with no more knowledge than we already possess of the action of the reagents on other bodies, we must pronounce this test to be very unreliable.

Falmouth, Jamaica, B.W.I.,
May 30th, 1888.

NEW METHODS FOR THE ESTIMATION OF SULPHUR IN STEEL AND STEEL-MAKING IRON.

By J. O. ARNOLD and HENRY J. HARDY.

There is a general consensus of opinion amongst analysts that the sulphur present in steel or iron is most accurately determined by ultimately weighing it in the form of barium sulphate. The preliminary operations by means of which the sulphur is obtained in a state suitable for precipitation vary somewhat with different operators, but they all resemble one or other of the two following methods in general procedure.

Aqua Regia Process.

In this method the steel is dissolved in nitro-hydrochloric acid, and the resulting solution is evaporated to dryness to render the silica insoluble. The dry mass containing the sulphate of iron is taken up in hydrochloric acid, the excess of the latter necessarily used being evaporated off, until only sufficient to retain the iron in clear solution is present. The concentrated liquid is then diluted and the insoluble residue is removed by filtration. The filtrate is next largely diluted and the sulphur is precipitated by means of barium chloride.

Evolution Method.

In this process the steel is attacked by a non-oxidising acid (dilute sulphuric or hydrochloric) and the evolved H_2S is absorbed in an oxidising liquid, such as bromine water or potassium permanganate solution. After removal of the excess of bromine or decomposition of the surplus permanganate, as the case may be, the sulphur is precipitated by barium chloride from a faintly hydrochloric acid solution.

In addition to methods such as the above, Eggertz has proposed a colorimetric process in which the sulphur present in the iron is approximately estimated by the intensity of colour produced on a silver plate by the evolved H_2S. Wiborgh has proposed a modification of the last method, in which cloth, saturated with cadmium nitrate is substituted for the silver plate.

Morgan (Chemical News, vol. lvi., p. 83) proposed to pass the gases evolved on treating 0·5 grm. of steel with dilute sulphuric acid into 50 c.c. of a dilute solution of lead acetate, and comparing the colour so produced with those obtained by treating in a similar manner steels standardised by the barium chloride method.

The author's experience of this process is that under the prescribed conditions the "colour" obtained (say from a steel containing 0·05 per cent S) is a very decided *precipitate*, and that consequently accurate comparison is impossible.

The process generally used in the laboratories of iron and steel works is the aqua regia method, and its almost universal adoption is no doubt justified by the accurate results yielded by carefully carried out estimations. But it is nevertheless anything but an ideal process, for several reasons.

1. The gases evolved during the solution of the steel are very irritating and injurious.

2. The sulphur in the reagents used during the analysis must be carefully estimated and the "blank" so obtained must be deducted from the gross weights.

3. Any appreciable amounts of acid over and above that necessary to retain the iron in solution causes the method to yield low results, and the exact point is not very easy to hit, and, if over-stepped, causes a precipitation of the iron.

4. The time occupied in making an estimation is about two days, twenty-four hours being usually allowed for the precipitation alone.

5. The barium sulphate obtained is sometimes difficult to filter; it is also occasionally impure with iron, and the removal of the latter with hydrochloric acid may entail loss. The dubious expedient sometimes recommended for the purification of the precipitate, namely, fusion with sodium carbonate and re-precipitation, seriously increases the length of an already tedious process.

The inconveniences enumerated above induced the authors to try and devise a rapid and accurate method for the estimation of sulphur in steel, and after many failures they have succeeded in elaborating two processes, one colorimetric and approximate, but very rapid, occupying only twenty minutes, the other volumetric and exceedingly accurate, occupying about an hour and three-quarters, or, if the estimation is made in duplicate, two hours and a half.

Both these methods are based on the generally admitted principle that the sulphur in steel or steel-making iron (in which 0·13 per cent may be considered as the maximum amount usually met with) is completely evolved as H_2S on heating the finely-divided metal (in small drillings) with dilute sulphuric acid (1 in 7). The authors have confirmed the accuracy of the above enunciation by numerous experiments.

Method I.

The apparatus employed in this process is represented in Fig. 1. 0·2 grm. of the steel is weighed out into the flask, A, which has a capacity of about 200 c.c. With the steel are placed a few small pieces of solid stick zinc (chemically pure) and about 20 c.c. of water. The tube, F, which is graduated at 30, 40, and 50 c.c., is about 20 m.m. in diameter and 300 m.m. in length, and contains 30 c.c. of a solution of sodic hydrate, prepared by dissolving 25 grms. of stick soda in a litre of water.

The cylinder, E, which should be graduated, contains dilute sulphuric acid (1 in 4). Both ends of the bent tube, D, are fused up so as to leave openings about the size of an ordinary wash-bottle jet, to prevent the too violent flow of acid. The end of the gas delivery tube, G, is also contracted, to break up the bubbles and facilitate absorption. The parts of the apparatus having been tightly fitted together, the water in A is boiled to expel the air from the apparatus. The india-rubber tube, C, is then closed with a clip, the position of the latter being indicated by the letter in the figure; the lamp is withdrawn and 15 c.c. of acid are allowed to pass into the flask from the cylinder, E, the india-rubber tube, B, being then closed with a clip.

As soon as the evolved hydrogen restores the equilibrium of pressure within the flask (which is indicated by the distension of the collapsed india-rubber connection

tube), the clip, C, is opened, when the gases bubble through the soda in F, which effectually absorbs the sulphuretted hydrogen. The sand-bath is gently heated until all the steel is dissolved; the more compact pieces of zinc, however, continue to act on the acid, and the evolved hydrogen carries into the soda solution the last traces of H_2S given off from the steel. The action is continued until the contents of the absorption-tube measure, after cooling, 40 c.c.*

To the fluid in the tube next add 10 c.c. of a dilute solution of lead acetate, containing in that volume enough acid to neutralise the soda and render the liquid distinctly acid.† A brown colour, due to the formation of PbS, is thus produced, proportional in intensity to the amount of sulphur present in the steel. Close the mouth of the tube with the hand and *gently* mix the contents. The percentage of sulphur is next determined by comparing the colour produced with that yielded by standards containing known quantities of PbS. These standards must be prepared in tubes exactly similar to the absorption tube, whilst the solution of the steel is proceeding, and the comparison must be made without loss of time.

The standard solution is prepared by dissolving 0·4725 grm. of pure crystallised acetate of lead in 1000 c.c. of

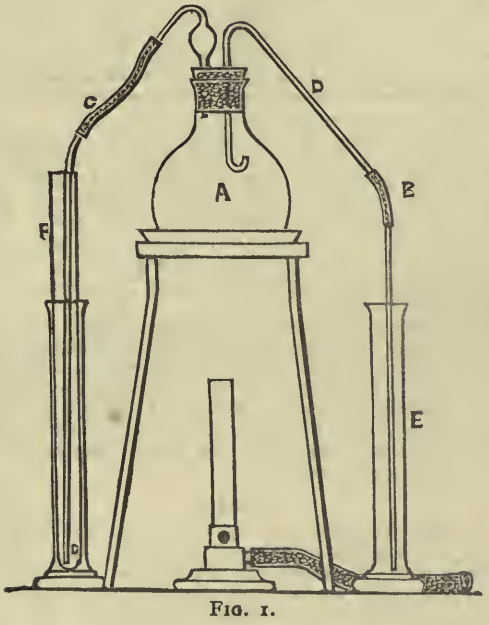

Fig. 1.

very dilute acetic acid; each c.c. of this solution thus contains lead equivalent to 0·02 per cent of sulphur in 0·2 grm. of steel.

To No. 1 standard is added 1 c.c., to No. 2, 2 c.c., and so on, advancing by increments of 0·02 per cent of sulphur. The standard tubes are then filled up with water nearly to the 50 c.c. mark, the exact volume in each case being made up with a slight excess of good H_2S water. The contents of each tube are then gently mixed. On comparison it will be readily seen to which standard the steel under examination most closely approximates, the odd hundredths, 0·01, 0·03, &c., being obtained by interpolation.

The results of numerous experiments on steels, in which the sulphur had been carefully determined as barium sulphate, lead the authors to fix the possible errors of this process as follow:—In steels ranging from 0·01 to 0·04 the divergence from the truth will never exceed 0·01 per cent; steels containing 0·06 to 0·1 per cent may yield results as far out as 0·02 per cent; impure steels containing 0·11 to 0·14 per cent occasionally diverge as much as 0·03 per cent. This process is consequently not adapted for cases where rigidly accurate results are required, but often in a steel works the information desired is, whether the material in question is a Swedish steel, containing say 0·01 per cent of sulphur, a high-class English steel, containing say 0·05, or an impure Bessemer steel, containing perhaps 0·1 per cent of sulphur. Such a query is accurately answered by the foregoing method in less than half an hour.

It may be mentioned in connection with this process that efforts have been made to obtain a stable standard sulphide solution, but in this the authors have been unsuccessful. They have also endeavoured to get standard tints, both with anilines and with inorganic salts, such as those of palladium, but all attempts in this direction have ended unsatisfactorily.

Method II.

This process gives results certainly less than 0·01 per cent from the truth, as the authors have carefully proved by comparison with the barium sulphate method. The figures obtained are also remarkably concordant. In one case the sulphur in an English steel was found by barium sulphate to be 0·07 per cent. Seven determinations were then made by the method about to be described, and on each occasion the result was sharply registered as 0·06 per cent, which the authors regard as the truer result. In another case the aqua regia process indicated the sulphur in a Swedish steel to be 0·01 per cent. Four estimations by the new method each gave the same results, namely, 0·01 per cent. A grey hematite iron which had been twice melted in a cupola was found, by the aqua regia process, to contain 0·12 per cent; an estimation by the new method registered the sulphur present as 0·11 per cent. The apparatus used is represented in Fig. 2. B is a glass gas-holder, having a capacity of about 5 litres. It contains pure hydrogen,* well washed in sodic hydrate, and when filled holds gas sufficient for two estimations. The flask, A, has a capacity of about 250 c.c., and is fitted with an india-rubber cork, in which is inserted a small separator, an exit tube of about 3 m.m. *external diameter*, and an inlet tube for the hydrogen of about 3 m.m. *internal diameter*. Weigh out into the flask exactly 2 grms. of the steel in fine drillings and add 20 c.c. of distilled water, adjusting the end of the hydrogen inlet tube so that it dips under the surface, connect the flask with the gas-holder and with the first cylinder on the stand, E, part of which, the rack, D, is movable,† and contains fifteen tubes about 75 m.m. long by 12 m.m. inside diameter. In each of these cylinders (except the first one, which is left empty to act as a condenser) is placed, by means of a burette, exactly 2 c.c. of an acid solution of lead acetate, made by dissolving 1·812 grms. of crystallised normal acetate of lead, $Pb(Ac)_2 3H_2O$, in weak acetic acid and diluting to 1000 c.c. Each tube thus contains a quantity of lead sufficient to fix as sulphide 0·01 per cent of sulphur in 2 grms. of steel.

A full-size sketch of two of the cylinders is shown in Fig. 3; the india-rubber cork is furnished with a straight exit tube 30 m.m. long, and an inlet tube, bulbed about 12 m.m. from the end, the bulb to be about 1 m.m. smaller than the cylinder in diameter. By means of this device a practically perfect absorption is obtained, so that the successive increments of 0·01 per cent of sulphur

This is best seen by making a mark on the tube, F, between the 40 c.c. and 50 c.c. graduations, the exact point depending on the volume occupied by the delivery tube *when full of gas*, the slight contraction of the liquid on cooling being also taken into account.

† A suitable solution may be made by mixing 300 c.c. of water with 200 c.c. of 35 per cent acid and dissolving in this liquid 1 grm. of $Pb(Ac)_2 3H_2O$.

* If air is used instead of hydrogen a small portion of the H_2S is decomposed and the result obtained is slightly low.

† By this arrangement a second rack containing tubes for a duplicate estimation may be prepared whilst the first determination is proceeding.

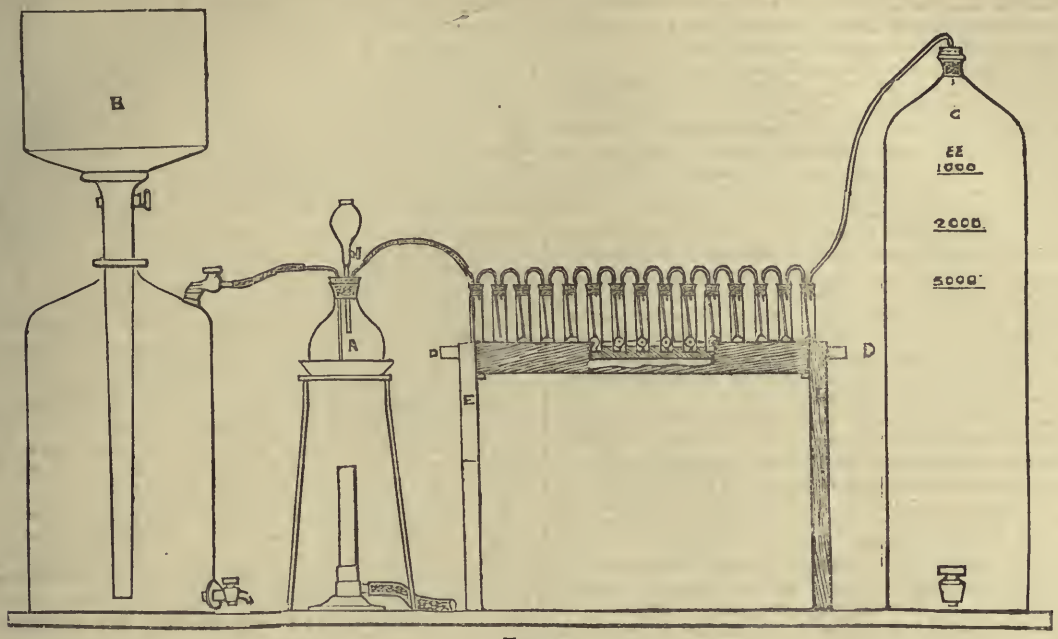

Fig. 2.

evolved from the steel are sharply separated, none passing a tube until the lead in solution is completely precipitated. When gas is passing the liquid is split into two parts, one

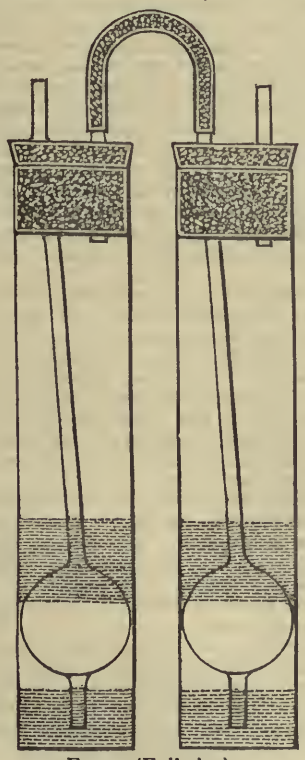

Fig. 3 (Full size).

under and the other above the bulb, so that, in addition to passing through two layers of absorbent, the gas is also sandwiched for a moment between the two liquid strata. The india-rubber tubing which connects the flask with the cylinders and the cylinders with each other must have a small bore and thick walls to prevent diffusion. The aspirator, C, is graduated in litres.

When all is ready, the air is swept out of the apparatus by forcing and aspirating through it 1 litre of hydrogen; the gas-holder tap is now shut, and 30 c.c. of dilute sulphuric acid (1 in 4) are run into the flask from the separator, the aspirator tap being fully opened. Gentle and intermittent heat is next applied to the sand-bath until the steel or iron is completely dissolved. The rate of the passage of the gas through the cylinders should be slow and regular. When all, or nearly all, action has ceased, the hydrogen tap is again opened and another litre of gas is aspirated through the apparatus.

As the operation above described proceeds, one by one the contents of the cylinders will blacken, each cylinder precipitated representing one-hundredth per cent of sulphur. The termination of the reaction is thus self-indicating, and all that remains to do is to count the precipitated cylinders. A faint colour in the last tube may be ignored, whilst a decisive tint, but still one short of complete precipitation, may be taken as representing only 0·005 per cent if such refinement is deemed necessary. There is no difficulty in deciding this point: the completely precipitated liquid is black-brown, the colour when semi-precipitated being dark ruddy brown, the tint communicated by a trace of H_2S is yellow-brown.*

It would seem at first sight that the appreciable solubility of H_2S in water must seriously affect the accuracy of the process, owing to the liquid in the cylinders nearest the flask retaining in solution H_2S over and above that necessary to precipitate the lead. But the current of hydrogen passed at the termination of the operation effectually carries forward every trace of sulphur until it is fixed by its equivalent of lead. This statement can be readily demonstrated by placing in a cylinder a very dilute solution of H_2S and attaching it to another cylinder containing lead solution. On passing hydrogen from the

* The authors have not yet applied the process to sulphurous irons, but probably by a suitable arrangement of standard solutions (*e.g.*, charging the first two or three cylinders so as to absorb increments of 0·1 per cent), accurate results may be obtained.

sulphide to the lead cylinder, the latter is at once precipitated, and after a little time the first cylinder will prove on testing to be quite free from H_2S.

Another point which has received the authors' careful attention was, whether the co-evolved phosphoretted hydrogen would affect the accuracy of the results. They have proved that such is not the case, and their conclusion may be demonstrated experimentally in the following manner:—Take 2 grms. of a steel containing about 0·05 per cent of sulphur and 0·05 per cent of phosphorus. In each of the first three cylinders of the apparatus already described place lead solution of a strengh sufficient to absorb completely the weight of sulphuretted hydrogen which will be evolved from the steel; in the fourth cylinder place a solution of nitrate of silver. On proceeding with the experiment exactly as in the sulphur estimation, the whole of the H_2S will be absorbed in the first tube; the second and third tubes will remain clear, quite unaffected by the phosphoretted hydrogen, which, however, produces a black precipitate in the fourth tube, containing the silver salt. The unfortunate fact that the phosphorus present is not completely evolved as hydride effectually extinguishes any attempt to apply the apparatus to the quantitative determination of phosphorus.

The authors considered it advisable to ascertain the effect of the presence of copper on the estimation of sulphur by the new process. Twenty-five pounds of grey pig-iron smelted from Spanish ores were melted with two ounces of commercial copper; the resulting metal proved, on analysis, to contain 0·43 per cent of copper. The sulphur yielded by the aqua regia process amounted to 0·017 per cent; that obtained by the new method was 0·02 per cent. Thus, the presence of copper does not impair the accuracy of the results. Under the conditions of the analysis the solution was found to be free from any trace of copper, and the whole of the latter was found to be precipitated in the metallic form along with the graphite and silica.

In conclusion, the authors commend this process to the notice of steel analysts, feeling sure that a method so rapidly carried out and so accurate in the results it yields will be gladly accepted in the place of an operation so tedious and disagreeable as the estimation of sulphur by the aqua regia and barium sulphate method.

The Laboratory, 34, Bank St.,
Sheffield, July 2, 1888.

POISONS AND POISONING.

By C. MEYMOTT TIDY, M.B., M.S., &c,
Professor of Chemistry and of Forensic Medicine at the London Hospital, &c.

(Concluded from p. 35).

There naturally follows on what I have said respecting this chemical action of poisons, the following important question:—

Given knowledge of certain properties of the elements, such as their atomic weights, their relative position, according to the periodic law, their spectroscopic characters, &c.;—or given knowledge of the chemical composition, the molecular constitution, together with the general chemical and physical properties of compounds; in other words, given such knowledge of the element or compound as may be learnt in a laboratory—does such knowledge afford any clue whereby we may predicate the probable action of the element or of the compound respectively, on the living body?

First let us limit our attention to the *elements*.

The starting-point of this inquiry was the toxic properties of the metals. The work of Blake (1841) in this direction was afterwards extended by Rabuteau (1867). Their observations led them to the general conclusion that "the physiological activity of the metals increased with their atomic weight." This broad general statement was modified at a later period by noting that the reverse was the case with certain groups of metals. Thus potassium (39) is more poisonous than sodium (23), and barium (137) more poisonous than calcium (41). These facts led Rabuteau to the conclusion that any comparisons of toxicity must be limited to the metals belonging to the same group. Husemann and Richet, however, pointed out that even this rule did not hold good, seeing that lithium having an atomic weight of 7, was far more poisonous than either sodium or potassium.

Experiments on the metals were further conducted by Richet with the metallic chlorides. Grain by grain, at intervals of forty-eight hours, he added the chlorides to water in which he kept fish of a given kind. He then recorded the maximum strength of the solution of the metallic chloride in which these said fish would live for forty-eight hours. The conclusion at which he arrived was that the limits of the toxicity of a metal bore no relationship either to its atomic weight or to any other chemical or physical characteristic of the metal.

Bouchardat and Stewart Cooper in a similar manner experimented with the non-metals. Selecting the haloid group of elements, they noted that their toxicity was inversely to their atomic weight, fluorine (19) being the most poisonous, and iodine (127) the least poisonous of the group, chlorine (35·5) and bromine (80) occupying their proper intermediate positions. But here again the group theory was inevitable. What was true of monad elements was not true of the elements of higher atomicity, the toxicity of selenium (79) being far greater than that of sulphur (32).

With these facts before us there arises this question, Was a relationship to be expected between physiological action and atomic weight? One poison acts on muscles—a second on nerves and nerve-centres—a third on the blood:—Is it likely, even supposing a relationship to exist betweed a certain group of elements and a given organ or a given structure, that the relationship would be the same in the case of all organs and all structures? These researches (the outline of which I have briefly indicated) suggest this much to future observers, viz.: First of all group your poisons according to their methods of operation, and then see how far the degree of toxicity of the terms of any one group show relationship to the atomic weights of such group.

But the difficulties of comparison thicken, when we consider the physiological action of certain allotropic modifications of the elements.

Thus compare *yellow* phosphorus, a body readily inflammable, soluble in bisulphide of carbon, firing by contact with iodine, with *red* phosphorus, a body at variance with the yellow variety in the three respects named. Nor is this all. For *yellow* phosphorus is an active poison, two grains being a certainly toxic dose, whilst *red* phosphorus is an absolutely inert body.

Take a second illustration. In its ordinary form oxygen plays the part of a life sustainer. But oxygen is only a life sustainer in its common form and at ordinary pressure

On this latter point I have no time to dwell, save to mention that if an animal be exposed to oxygen at three pressures, the resulting symptoms are not unlike those induced by strychnine.

There is, however, an allotropic form of oxygen called *ozone*. The physiological action of ozone was the subject of a communication to the Royal Society of Edinburgh by Dewar and McKendrick (1873). Their experiments were made on both cold- and warm-blooded animals, including amongst the latter themselves and their assistants.

The results are remarkable, more particularly when we remember that the air with which they operated at most only contained 10 per cent of ozone.

* A Lecture delivered before the Royal Institution of Great Britain, March 2, 1888.

Placing a large frog in a jar of air, and then ozonising the air, the frog in about half a minute closed its eyes, the respirations fell from 96 to 8 per minute, and the body temperature was lowered 4° or 5° C. The animal recovered in about 8 minutes, when pure air was admitted into the receiver. Death resulted if the animal was exposed for any lengthened period to the action of the ozonised air.

As regards the action of ozone on warm-blooded animals, Dewar records certain personal experiences, chief amongst which were a tendency to breathe slowly, an enfeebled pulse, and fits of sneezing.

But now comes the curious part of the story, viz., that at the *post-mortem* on the animals that died under the influence of ozone, the blood was found to be *venous*. (The results were similar when pure ozonised oxygen was employed). It is most remarkable that the *post-mortem* appearances of death from an intensified oxygen should resemble those of death from carbonic acid.

I give these illustrations to show why there should be reason to doubt whether the physical or chemical properties of an element can ever suggest either toxic activity or physiological action.

2nd. *Compounds.*

Is there any relationship between the chemical composition or constitution of a compound body and its physiological action?

The first series of researches on this question was directed to determining whether, in the case of a salt, the acid or the base was, physiologically, the most important ingredient (Blake, 1841).

No doubt most often the active agent of a salt is the base, but this is by no means uniformly the case. Probably the solubility of a compound and the different proportions of acid to base in the salt (*i.e.*, whether the compound in question be an acid or a basic salt) are agencies which also help to determine the toxicity of the body and its physiological action.

A second series of experiments was made by Blake for the purpose of showing that, given a series of isomorphic salts, the intensity of physiological action increased with the molecular weight. He further contended that salts crystallising in different forms had different physiological actions. On this basis he constructed a series of nine groups of salts, each group being characterised by special physiological actions, insisting with much reason that we possess in living matter a reagent (so to speak) capable of aiding us in our investigations into the molecular properties of chemical compounds. If from molecular constitution you can determine physiological action, probably from physiological action, conversely, you may determine molecular constitution.

Another series of experiments in a similar direction were made by Schoff on the Continent, and by Fraser and Crum Brown in this country.

Of these experiments the most important are those indicating how, from bodies of vastly different physiological action, you may obtain derivatives having similar properties.

For example, the physiological action of *strychnine* is primarily exerted on the spinal cord. As a result, convulsions occur as a prominent symptom. But if we introduce into the strychnine molecule a methyl group (forming methyl-strychnine), the action of the drug is altered—methyl-strychnine paralysing (strychnine stimulating) the motor nerves.

But here comes a curious fact. If we take morphine, or nicotine, or atropine, or quinine, or veratrine (none of which bodies are comparable in their physiological action to strychnine), and convert them into their methyl derivatives, the methyl compounds formed (viz., methyl-morphine, methyl-nicotine, &c.) are comparable in their physiological action to methyl-strychnine.

We must admit these experiments to be striking. One treasures any experiment suggestive of the chemical constitution of a body indicating physiological action.

But again:—The true physiological action of a drug is not so much its general as its selective action, this selective action being largely dependent on the *dose* administered and the mode of administration.

For example:—Inject into the circulation of a frog a *small* dose of *veratrine*, great muscular stiffness results, a *large* dose similarly administered not producing this effect. And now change the method of administration: Apply the *small* dose directly to the muscle, you get no symptom; but apply the *large* dose directly, and great muscular stiffness results. Here see the modifying influence of dose and of the mode of administration.

Again, the difficulty of "allotropism" in the case of elements finds its counterpart in "isomerism" in the case of compounds. Thus, cyanogen and para-cyanogen are bodies of identical *percentage* composition, and yet cyanogen is one of the most poisonous of gases, whilst para-cyanogen is one of the most inert of solids.

Or, again, take *piperin* and *morphine*. These bodies are of identical percentage and molecular composition. They agree (it is true) in being poisons. But how vastly different their physiological action!—the one an extreme irritant, the other a powerful narcotic.

I fear we must admit that, as no *à priori* reasoning could predict that by combining copper and sulphuric acid a blue salt would be formed, so no *à priori* reasoning, no knowledge of chemical constitution, can predicate what will be the special organ on which any given poison will act, nor, even supposing that the organ upon which the chemical activity of the drug will be exerted be known, what will be the nature of such chemical action. The science of drugs, like the science of chemistry, is, and must ever remain, an experimental science.

And, be it remembered, the poisons of the toxicologist are the medicines of the physician. Physiological action is a subject-matter for experiment. Let the guard be jealously set and as rigidly maintained to prevent cruelty to animals; but ask yourselves, whether to rob the higher creation of life and health rather than that one of the lower creation should suffer, be not a refinement of cruelty—the cruelty of cruelties? "Are ye not of much greater value than they?" speaks a still small voice amidst the noisy babble of well-intentioned enthusiasts.

Two general observations are suggested. And this first:—The later age history of poisoning is the history of a profession. This profession we find closely associated, not only with the profession of medicine (the art of healing), but with witchcraft, incantation, and charms. The threefold arts of poisoning, witchcraft, and medicine, moreover, became so closely allied to religion as to claim, each and all, the shield of a sacred sanction and the protection of a divine voice. Even that very word φάρμακις, the Greek for "*a dispenser of medicines*," is the same word used to imply "*a witch*" and "*a poisoner*." The modern scientist has once and for ever shattered the bond that united science with superstition. It was a special ministry of science to teach men that in the preparation of medicines the pharmacist required no stuffed crocodile to preside over the mysteries of his laboratory, nor incantation to give virtue to his drugs!

And this secondly: the villanies of the early poisoners can never again be practised in the light of the science of the nineteenth century. Science can and has done what legislation could never do. The Hebrew Scriptures speak of a time when "the sucking child shall play on the hole of the asp, and the weaned child shall put his hand on the basilisk's den" (Is., xi., 8, Rev. Ver.). Is not science working out some such consummation as this? I claim that a science which, like a blood-hound, can track with cunning scent the minutest atom of a poison in the body, *is* helping forward the day when poison shall cease to be the instrument of a secret treachery, because there are eyes it cannot hope to evade, and a science whose investigations it will not dare to defy.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending June 30th, 1888.

By WILLIAM CROOKES, F.R.S.;
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To General A. De Courcy Scott, R.A.,
Water Examiner, Metropolis Water Act, 1871.

London, July 7th, 1888.

Sir,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from June 1st to June 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

During the past month a considerable proportion of the daily samples, drawn from the East London Company's mains, have been found, when examined by transmitted light, to be slightly turbid, from the presence of finely diffused, suspended mineral matter, attributable to the considerable disturbance of the Company's mains by the provision now being made of a number of new hydrants.

With this exception the character of the entire supply of water to the Metropolis by the seven Companies, dependent on the Thames and the Lea, has been thoroughly satisfactory.

Attention has been called from time to time to the, for the most part, minute seasonal differences in the composition of filtered river-water as it is supplied to London. Such a difference is noticeable when comparison is made of the mean results of the examinations conducted during the past month of June, with the closely agreeing mean results of the examinations made in the previous months of April and May. Thus the mean numbers expressing the organic carbon, the oxygen absorbed, and the degree of colour-tint of the Thames-derived water supplied during the months of April and May, being 0·157, 0·046, and 16·2 respectively, the corresponding numbers for the month of June were found to be 0·147, 0·038, and 11·6 respectively.

Moreover, the maximum amount of organic carbon in any one sample examined in April and May being 0·183 part in 100,000 parts of the water, the maximum amount found in any one sample examined during last month was only 0·157 part,—a proportion but little removed from the mean or 0·147 part in 100,000 parts of the water.

During the past quarter of the year we have examined 532 samples of the water furnished by the seven London Companies taking their supplies from the Thames and the Lea. Notice has been taken of the recent deficiency in clearness of many samples of the East London Company's water. Throughout the quarter, however, the whole of the samples taken from the other six Companies' supplies of water were found to be well filtered, clear, and bright.

We are, Sir,
Your obedient Servants,

William Crookes.
William Odling.
C. Meymott Tidy.

NOTICES OF BOOKS.

Alkali, &c., Works Regulation Act, 1881. *Twenty-fourth Annual Report on Alkali, &c., Works by the Chief Inspector.* Proceedings during the year 1887 presented to the Local Government Board and to the Secretary for Scotland. London: Eyre and Spottiswoode.

The first point here to be noted is the number of chemical works registered under the Act. These amount now to 927 in England and Ireland, being an increase of 17 as compared with the total in 1886. In Scotland the registered works amount to 139, making the grand total for the United Kingdom 1066. But though the entire number of chemical works has thus increased that of alkali works, strictly speaking, has progressively decreased during the past three years. In 1885 there were in operation 132, in 1886 118, and in 1887 only 116. It is noted that the works themselves have been very generally enlarged, and that in most of them several processes are being carried on. The total number of alkali works is given as 66; places where hydrochloric acid is made by the cylinder process, 28; copper works using the wet process, 21; carbonising cotton, 7; sulphuric acid works, 324; chemical manures, 242; gas-liquor works, 26; nitric acid, 96; manufactories of sulphate and muriate of ammonia, 311; chlorine and bleaching-powders, 58; salt, 78; and cement, 94.

During the year 4383 visits have been made and 4402 tests applied. We are glad to find that the principles of Dr. Angus Smith are still being carried out. If the inspectors find some works in an unsatisfactory condition they make repeated visits, not with a view to obtain evidence for a prosecution, but to effect the needed improvement,—to trace out the source of the difficulty and assist in finding means for its removal. The Report informs us that "such action on the part of the inspector, though not always welcome at the time, is ultimately acknowledged with satisfaction by the manufacturer, and the expense that may have been incurred is felt in the end to be money well spent."

Obviously such a policy on the part of the inspectors demands not alone a sound practical insight into the physics and chemistry of the question, but it requi es courtesy, firmness, and tact. But we shall not be accused of flattering Mr. Fletcher and his assistants if we say that in their hands the Act is being worked admirably—that is, with the greatest possible protection to the public against injury and nuisance, and at the same time with the minimum of inconvenience to the manufacturer. The following figures will show that we are not painting the result too much in rose-colour. The hydrochloric acid in the chimney-gases, calculated as grains per cubic foot, has been for the last three years stationary at 0·10. The proportion of hydrochloric acid escaping as compared with that generated, which was 2·39 per cent in 1885 and 2·13 in 1886, was in 1887 only 1·99. The acid gases escaping from the chambers given as grains of sulphuric anhydride per cubic foot, is nearly stationary. In 1885 it was 1·52, in 1886 1·40, and last year 1·50. The total acidity of chimneys given as SO_3 varies little, the amounts for the last three years being respectively 0·67, 0·77, and 0·74. In the acidity of gases from manure works there has been a steady improvement from 0·67 grain in 1885 to 0·44 in 1887.

All these figures are well within the limits fixed in the Act. The escape of hydrochloric acid has been 1-10th grain for each cubic foot of chimney smoke. The Act allows double the quantity. The proportion of the same acid gas which may lawfully escape is 5 per cent of the total generated. In practice it is now less than 2 per cent. The limit enacted for the escape of chamber gases is 4 grains of sulphuric anhydride per cubic foot, whilst the average actual escape is now 1¼ grains.

Only four prosecutions under the Act took place during

the year. Three of them were for neglecting to register works which came within the scope of the Act, and one, a manure works was for not using the best known means for preventing nuisance.

A very important point mentioned in this Report is the struggle between the Leblanc and the Solvay alkali processes. About £3,000,000 are supposed to be inxested in the Leblanc process, and most of this would be wasted if the Solvay process is successful. The question seems to turn mainly on the by-products. If the Solvay makers can utilise their chlorine, so as to produce bleaching-powder and chlorate of potash as cheaply as their rivals, the Leblanc works must be closed. If, on the other hand, the Leblanc makers can recover more available chlorine from the salt decomposed, and if they can further recover the sulphur now thrown away in the form of vat-waste, their future is secured. It is here mentioned that Messrs. Chance, of Oldbury, recover very nearly the whole of the 15 per cent of sulphur present in this waste. The quantities of vat-waste existing and still produced are fearful. Deposits of it at Widnes cover 450 acres and contain about 8,000,000 tons, to which there is made a daily addition of 1000 tons. The total yearly production is no less than 1½ million tons.

The total weight of salt decomposed in the alkali manufacture was, in 1887, 736,017 tons, of which 577,381 tons were used in the Leblanc process.

Hopes are expressed that either by means of Mr. Hargreave's thermomotor, or Mr. Mond's system of producing fuel gas, the production of black smoke may come to an end.

Not the least useful part of the Report is that where the Inspector points out the omissions and anomalies of the Act as it stands. Thus, a variety of processes in which sulphuretted hydrogen is given off are under no control. The production of sulphurous acid for any purpose save the manufacture of sulphuric acid does not fall within the cognisance of the inspectors. Though the manufacture of nitric, sulphuric, and hydrochloric acids is strictly regulated, yet their use is not noticed, however great the quantities of acid fumes given off. The use of nitric acid, *e.g.*, does not come within reach of the Act unless some process is adopted for condensing the fumes. "This is generally accomplished by a process of oxidation in which nitric acid is re-formed. As this, in a sense, is a manufacture of nitric acid, the operation comes under the Act and the works are inspected, and in an extreme case, if the condensation and retention of the acid were negligently and imperfectly performed the manufacturer might be fined. But should a neighbouring manufacturer make no attempt at condensation, but allow the whole of his nitrous fumes to escape unchecked, he would do so with impunity as far as the Alkali Act is concerned."

It would be well if the Act could be extended so as to embrace all offensive gases or vapours, from whatever business arising, and if the measure could be not "cumulative" but codifying, so as to embrace the entire law as regards volatile or air-born nuisances.

CORRESPONDENCE.

THE MATHEMATICAL INVESTIGATION OF CHEMICAL PHENOMENA.

To the Editor of the Chemical News.

Sir,—Whilst recently examining the subject of molecular stability I have been convinced of the value of mathematical reasoning to chemical science. We can often apply mathematical analysis to explain the probable nature of a chemical change where chemistry itself would help us very little. I feel confident that as mathematics has raised pure physics to what it is, we may expect that chemical phenomena may be rationally dealt with, and explained with great advantage.

Why is it that we cannot generalise on known chemical facts so as to predict a result without the chance issue of experiment?

I have often heard it said that chemistry and mathematics do not blend well in the scientific mind. Mathematicians have certainly not given that assistance to chemistry which might have been expected, and this can only be explained by assuming that rigidly mathematical methods are beyond the grasp even of an intelligent and well-informed average chemist.

A fair knowledge of the differential calculus and trigonometry, so far as being able to deal with the transformations of angular functions, is a very powerful help to the chemical physicist.

Mathematicians make the mistake of writing exclusively for a well-trained mathematical mind, with the result that chemists will not, as a rule, trouble themselves to examine the methods or deductions.

Chemists can only recognise realities and can only accept probabilities so far as they are consistent with experimental deduction; these are advantages of primary importance, and which, I am sure, will not be surrendered. Accurate and careful observations are the very first requirements in a conscientious chemist.

There are certain chemical changes which we know are produced by heat, electricity, &c., and which purely chemical methods cannot detect; these changes are revealed to us by the thermometer, expansion, galvanometer, electrolysis, &c.

The elements arsenic, antimony, and bismuth stand, as it were, on the border-land of metals and non-metals. Arsenic alloyed with copper reduces the electrical conductivity of the latter as no true metal does; it behaves more like a non-metal, as sulphur, oxygen, phosphorus, &c. Then follows antimony and bismuth. The non-metals have a very high resistance, but the resistance of a copper wire containing a little oxygen or sulphur cannot be expressed by the average resistance, but if we assume that the copper compounds are formed and exist as masses, offering an impediment, *en bloc*, to conduction, and intermingled with the remaining copper, the phenomenon is intelligible.

Dissociation of a compound or alloy at high temperatures we know does take place. It is quite possible to determine the energy required to break up, say, a compound molecule, and to express the same in terms of the mechanical unit. It is no less easy to determine what compounds are possible to exist at certain temperatures. Chemistry alone will not help us here, but still these considerations come fairly within its domain; the sooner we recognise this fact the better. There is an idea that chemistry and physics must be severed. I am sorry to record this, especially when we bear in mind the recent chemical applications resulting from electrolysis.—I am &c.,

Thomas T. P. Bruce Warren.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of emperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 2, July 9, 1888.

Researches on Hexagonal Phosphorescent Blende—A. Verneuil.—The würtzite obtained artificially is very phosphorescent if we cause a desulphurising agent to act upon the original blende. The phosphorescence of this

product, formed in a neutral atmosphere, is the more lively the lower the temperature at which it is produced.

Certain Compounds of Yttrium.—A. Dubois.—The author has prepared certain compounds of yttrium by the dry way. Among those obtained are a silicate, Y_2O_3,SiO_3, analogous to neutral gadolinite, and a crystalline yttrium oxide.

Syntheses by Means of Cyanacetic Ether.—Alb. Haller.—The author has obtained the ortho-toluylic, phenacetylic, cinnamyl, and di-cinnamyl-cyanacetic ethers by the process which he formerly used and described for the preparation of the benzoylic, acetylic, propionylic, &c., ethers. The author purposes studying the action of ammonia, aniline, &c., upon all these cyanic ethers.

On Pimelic Acid derived from Menthol.—G. Arth.—A critique of the researches of Herr Mehrländer. M. Arth thinks that the constitution of the acid, $C_7H_{12}O_4$, is not yet established, and the series of oxidation products of menthol imagined by Herr Mehrländer is still hypothetical.

The Alkaloids of Cod-liver Oil.—Arm. Gautier and L. Mourgues.—The fraction boiling from 87° to 90° contains butylamine; that from 96° to 98°, amylamine; a little above 100°, hexylamine; that boiling 198° to 200°, hydrolutidine, a new base; part of the fixed bases giving a hydrochlorate immediately precipitable in the cold, asselline, a new base; portion of the fixed bases yielding a very soluble chloroplatinate which crystallises from the mother-liquors of the former, morrhuine, a new base. There exists also in cod-liver oil a little lecithine and a very peculiar crystalline nitrogenous acid, *gaduinic acid.* It is at once a powerful acid and an alkaloid capable of forming crystalline chloroplatinates.

The Production of Propylene Iodide by the Fixation of Hydriodic Acid upon Allyl Iodide. Transformation of Propylene Iodide.—H. Malbot.—Simpson announced that allyl iodide was directly convertible into isopropyl iodide by a current of hydriodic acid. Erlenmeyer admits the formation of propylene as an intermediate product. The author finds that a large quantity of propylene iodide is produced, and, according to circumstances, is transformed into isopropyl iodide, without escape of propylene, or is split up into propylene and iodine without formation of isopropyl iodide.

Action of Ammonia upon Epichlorhydrine.—Ad. Fauconnier.—The author obtains, by a process which he describes in full, trichlor-oxy-propylamine, a very unstable base, $(C_3H_6ClO)_3N.HCl$.

The Peptonic Fermentation of Meat.—V. Marcano.—If chopped meat is mixed with the juice and the pressed tissues of the agave the fibrine is dissolved in five or six hours with a yield of 20 per cent of peptone, which is almost theoretical.

Zeitschrift fur Analytische Chemie.
Vol. xxvii., Part 1.

Analysis of Nickel Silver.—Dr. Felix Oettel.—The solution obtained by dissolving the metal in nitric acid, and thus, if needful, freed from tin, is evaporated with sulphuric acid (using to ½ grm. metal 15 or 20 drops of the mono-hydrated acid), and thus separating out the lead as sulphate. To the liquid thus freed from lead and tin, and amounting to about 100 c.c., there are added 2 c.c. of strong hydrochloric acid and sulphuretted hydrogen is passed in. When the precipitation is complete, which is known by the rapid subsidence of the copper sulphide, it is heated for a few minutes to a boil, cooled again, a few bubbles of sulphuretted hydrogen are passed in (which occasion no turbidity if the precipitation was complete), and filtered. The copper sulphide thus obtained, which is rather dense and does not readily oxidise in the air, is washed on the filter, first with very dilute hydrochloric acid containing sulphuretted hydrogen, and then with water (to which a little sulphuretted hydrogen-water has been added) until the acid reaction disappears. When dry it is weighed as a sulphide in a Rose crucible. It is necessary to add a little sulphur before heating only if the quantity is very trifling. As soon as the odour of sulphurous acid has disappeared it is still ignited for three minutes in a slow current of hydrogen, and is then allowed to cool in the same current. When thus obtained the copper sulphide has at once the correct weight. When the copper has been removed the zinc is separated according to the method of Smith and Brunner, by passing sulphuretted hydrogen into a perfectly neutral solution. After some time a few drops of sodium acetate should be added to neutralise the acid liberated and prevent imperfect precipitation. The author, however, prefers to add the sodium acetate at once after neutralising and before introducing the sulphuretted hydrogen. White pulverulent zinc sulphide is then deposited, which, after standing for a few hours, may be filtered and washed with sulphuretted hydrogen water without running through the filter turbid. The precipitate, when dry, is ignited in a Rose crucible in a current of hydrogen, and weighed as zinc sulphide. The solution still contains nickel, cobalt, iron, and generally a little manganese. The filtrate is boiled to expel sulphuretted hydrogen, oxidised with bromine water, the iron precipitated with ammonia as a basic salt, purified by re-precipitation, the mixed filtrates are rendered strongly ammoniacal and submitted to electrolysis. Nickel and cobalt separate upon the platinum cone as a firmly adhesive layer. When the precipitation is complete the cone is lifted out, rinsed with the washing bottle, plunged in ordinary alcohol, and dried over a small gas-flame. Any manganese present is separated out during the electrolysis in brown flakes; it is filtered off and weighed as mangano-manganic oxide.

Determination of Alumina in Presence of Ferric Oxide and Phosphoric Acid.—L. Blum.—This paper will be inserted in full.

Detection of Sodium Phosphate in Vitreous Phosphoric Acid.—Anton Battendorff.—This impurity may be detected by dissolving the sample in strong hydrochloric acid. Sodium chloride remains on account of its sparing solubility in strong hydrochloric acid.

Method for Generating Pure Non-arseniferous Sulphuretted Hydrogen.—Clemens Winckler.—The author takes 100 parts heavy spar, 25 parts of coal-dust, and 20 parts of common salt. The two former ingredients are finely ground, the salt is added, and the whole made up with a little water into a ball, which is rammed into a crucible of 25 c.m. in height and 10 c.m. in width. When dry some coarse coal is laid above the mass, the lid is put on, luted down, except a small vent-hole, and heated for some hours to incipient whiteness. The heat is then let go down, the crucible taken out of the furnace, and let cool quickly. The barium sulphide must be preserved in stoppered bottles in a dry place. With dilute hydrochloric acid it yields a very regular current of sulphuretted hydrogen, free from arsenic.

New Apparatus for the Direct Determination of Carbonic Acid.—O. Ostersetzer.—This paper cannot be reproduced without the accompanying cut.

Apparatus for the Extraction of Fats.—O. Foerster.—This paper requires the accompanying illustration.

Examination of Powdered Spices.—Eugene Borgmann.—As a preparation for examination with the lens the author stirs up 1 grm. of the powder with 10 c.c. of water and pours the whole rapidly upon a slab of unglazed porcelain. As the water is absorbed the powder is left upon the plate finely distributed, so as to be ready for examination.

The Use of Asbestos in Filtration.—W. Fresenius.—Liquids containing very finely divided matter in sus-

pension may be brought to settle by shaking them up with asbestos.

Determination of Arsenic in Pyrites.—H. Fresenius.—The fusion method offers no advantages in comparison with the direct distillation with ferrous chloride of a solution obtained by heating in a current of chlorine or by treatment with hydrochloric acid and potassium chlorate.

Indicators for Alkalimetry and Acidimetry.—A number of substances proposed in the *Analyst*, Chemical News, *Pharmaceutical Journal*, *Comptes Rendus*, *Journal of the Society of Chemical Industry*, and *Chemiker Zeitung*. It is remarked by E. Dietrich that blue litmus-paper becomes more sensitive if kept for some months, whilst the sensitiveness of red litmus and turmeric papers is unchanged.

Separation of Alumina and Glucina.—A. Zimmermann.—The author has examined the methods hitherto proposed, and finds the results partly uncertain and partly quite useless. The best method is the use of pure potassium hydroxide, in which, if in excess, glucina dissolves in the cold and is again deposited on boiling. A volume of 300 c.c. solution, containing 0·3 grm. of substance, allows of a perfect separation. If the liquid is much diluted, alumina falls along with glucina. Caustic soda is not applicable.

Determination of Small Quantities of Bismuth and Antimony in Commercial Copper.—P. Jungfer.—The author dissolves the copper in nitric acid, dilutes slightly, adds sodium carbonate drop by drop, stirring well, until a slight permanent precipitate has been produced, stirs further for a few minutes, and lets stand for an hour or two in order that any bismuth remaining in solution may have time to undergo double decomposition with the basic copper carbonate deposited. The precipitate is filtered through a small filter, dissolved in a few drops of hydrochloric acid, and diluted with water. The bismuth is then deposited as basic bismuth chloride, which is collected upon a tared filter, dried at 110° and weighed. If a residue appears on dissolving the copper it is filtered off, melted with sodium carbonate and sulphur, and examined for bismuth. For separating small quantities of arsenic and antimony from copper Flajolot proposed a method based on the different behaviour of the iodides of the above elements. The copper iodide is almost insoluble in feebly acid solutions in which arsenic and antimony iodides (the latter in presence of tartaric acid) are readily soluble. P. Jungfer has re-examined this method, and finds that along with copper arsenic remains entirely in solution, and that antimony, even in presence of tartaric acid, is partially carried down, and can be removed only by very protracted washing. This objection the author gets over by adding to the solution a little potassium fluoride *before* the potassium iodide; in this manner the copper iodide can be freed from antimony by a short washing, even if the addition of tartaric acid is omitted. For determining small quantities of antimony in copper the author dissolves 10 grms. copper in 50 c.c. nitric acid of specific gravity 1·4, dilutes the solution in a large beaker to 200 to 300 c.c., and after adding 150 m.g. of dissolved potassium fluoride, mixes with potassium iodide and sulphurous acid. The precipitation of the copper iodide is effected in the cold by adding the requisite potassium iodide, not at once but in successive portions alternately with sulphurous acid, avoiding an excess of the iodide. The beaker is set on a boiling water-bath until the precipitate has deposited, the contents are then filtered, and the precipitate is washed by decantation three or four times with hot water containing sulphuric acid. After the excess of sulphurous acid in the filtrate has been removed by means of solution of iodine, sulphuretted hydrogen is introduced for a long time. The precipitate produced contains, along with arsenic and antimony, a little copper and any lead and bismuth which may be present. The sulphides are filtered off and dissolved in hydrochloric acid with a little potassium chlorate. From the liquid thus obtained, after adding tartaric acid and excess of ammonia, copper, lead, and bismuth may be removed by the cautious addition of sulphuretted hydrogen water. After the precipitate has been gently heated and stirred for a short time it is rapidly filtered, and arsenic and antimony in the filtrate are separated from each other in the ordinary manner.

Quantitative Determination of Gold and its Separation from the Platinum Metals.—L. Hoffmann and G. Krüss.—Noticed already under *Liebig's Annalen* It is remarked in the work of R. Fresenius on "Quantitative Analysis," 6th Edit., vol. i., p. 623, that gold can be separated from all the oxides of the groups I. to V. by means of oxalic acid with the exception of lead oxide, mercurous oxide, and silver oxide in hydrochloric solution. Hoffmann and Krüss remark that soluble mercurous salts cannot exist in presence of auric chloride, as they become converted into mercuric compounds, and reduce the gold to aurous oxide. If, therefore, gold and mercury exist simultaneously in a solution, both must be in the higher state of oxidation, and in this case oxalic acid is the only good agent for their separation.

On Sulphurous Acid and Iodometry.—J. Volhard.—Sulphurous acid is decomposed by hydrogen iodide with formation of iodine, water, and sulphur (a little hydrogen sulphide). Sulphurous acid in a saturated aqueous solution is decomposed by hydrogen iodide. The iodine is here not set free, but re-converted into hydrogen iodide with formation of sulphuric acid. Thus, the total result of the reaction is a catalysis of sulphurous acid into sulphur and sulphuric acid. This reductive action of hydrogen iodide is avoided if a moderately strong solution of sulphurous acid is poured into the solution of iodine. With this modification Bunsen's iodometric method is the most accurate known.

A Peculiar Reaction of Malonic Acid.—S. Kleemann.—Malonic acid dissolves readily in acetic anhydride in the cold. If the solution is heated carbonic acid is evolved, the liquid turns yellow and then reddish yellow, with a very strong yellowish green fluorescence like fluoresceine.

Detection of Furfurol.—H. Schiff.—The author adds a mixture of equal volumes of xylidine and glacial acetic acid mixed, containing also a little alcohol. This reagent gives an intense red colour, even with minute traces of furfurol.

Kjeldahl's Determination of Nitrogen.—Karl Ulsch.—The author had formerly recommended an addition of copper oxide and platinum chloride during the action of the sulphuric acid. He now gives a caution against the use of an excess of platinum chloride and against prolonged heating.

Volumetric Determination of Phenyl-hydrazine.—E. von Meyer.—From the *Journal für Prakt. Chemie.*

Influence of Inactive Bodies upon the Rotatory Power of the Solutions of Tartaric Acid.—D. Gernez.—Noticed under *Comptes Rendus.*

Determination of Acetic Acid in Liquids containing Organic Matter.—H. W. Wiley.—From the *Americau Chemical Journal.*

Examination of Water.—According to Meade Bolton the number of bacteria in a sample of water shows neither its chemical nature, nor its degree of pollution, nor the danger of infection. Heräus and Flügge recommend that samples of water should be put in glass tubes, previously sterilised, sealed before the blowpipe, and packed in ice.

Milk. — Matthew A. Adams. — From the *Analyst.* Methods indicated by other chemists are given, taken from the Chemical News, *Analyst*, *Journal of the Chemical Society*, *Chemiker Zeitung*, *Comptes Rendus*, &c. According to the *Pharmaceut. Zeiting*, H. Thoms has detected ultramarine in a sample of trade-milk.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

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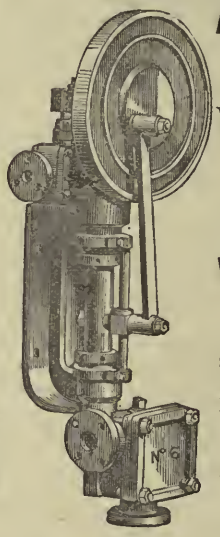

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1497.

TESTS FOR SO-CALLED SACCHARINE, ANTIPYRINE, AND ANTIFEBRINE.

By DAVID LINDO.

Saccharine.

The detection of this substance when mixed with other matters will seldom, I imagine, be possible unless it is first isolated in a state of at least tolerable purity. Chemical tests that can be easily applied for its identification in this condition are probably known and may have been published, but I have met with none, except production of salicylic acid from the compound by fusing it with potash or soda.

I have failed as yet to obtain a characteristic reaction for the substance in solution; the following test, which must be applied to the solid body, is believed to be original. It consists in evaporating to dryness on the water-bath, the saccharine mixed with excess of nitric acid; a fragment of caustic potash (not too small) is then added, and a drop or two of water, without removing the dish from the bath. Colour is at once developed, and if the dish is inclined streaks of colour, blue, violet, purple, and red, flow from the caustic; the reaction is very fine, and still more beautiful if 50 per cent alcohol is added to the potash instead of pure water. The test, however, is not extremely delicate; half a milligramme of saccharine in the solid state is about the smallest quantity that will give definite results. Heat is necessary to develop the colours, and apparently large excess of alkali. Soda does not appear to act as well as potash.

Colour reactions obtained with coal-tar products must always be suspected of not being characteristic; whether the one here described is peculiar to saccharine remains to be ascertained. Vitali's test for atropia is carried out in a somewhat similar manner, but requires an alcoholic solution of potash, and the colours are different.

Antipyrine.

Knorr, who appears to have discovered antipyrine gives reactions by which it can be identified.

1st. Even a highly dilute solution of the substance in water gives a red colour on addition of a drop of ferric chloride solution.

2nd. This depends on the formation of what Knorr, in 1884, called diquinizine blue. The solution of antipyrine is mixed with a dilute solution of nitrite and a few drops of dilute sulphuric acid added. If the quantity of antipyrine present is not too minute a blue colour is developed, otherwise the colour may be green.

Knorr (*Journal of the Chemical Society*, 1884, p. 1378), states that nitro-antipyrine is obtained by gently heating a solution of antipyrine in concentrated nitric acid, that it crystallises in white needles, is insoluble in water and alkalies, but is sparingly soluble in strong nitric and hydrochloric acids. It is scarcely likely he overlooked a fine colour reaction, which may be obtained by heating antipyrine with strong nitric acid in a small porcelain basin over the lamp until reaction commences; the lamp is then withdrawn, and when the reaction ceases a fine purple-coloured liquid residue remains. On adding water and filtering a beautiful purple-red filtrate is obtained, and a violet-coloured precipitate remains on the filter. The reaction is very delicate. I have seen no reference to it in the abstracts of Knorr's papers that have come under my notice, nor elsewhere

Antifebrine.

I have met with no published tests for this body, and the only one I have discovered as yet must be applied to the solid substance; a very minute quantity, however, will suffice. The test depends on the fact that when antifebrine is heated strongly with concentrated sulphuric acid sulphanilic acid is formed, or at least a body which reacts exactly like it with nitrous acid and phenols. A small quantity of antifebrine is placed in a porcelain basin, a little pure concentrated sulphuric acid added, and heat applied with a naked flame until the acid fumes strongly; when cold, add a little water and mix with very highly dilute solution of nitrite; the mixture can now be tested with α-naphthol, thymol, or carbolic acid.

For further particulars I must refer to a former paper of mine, published in the Chemical News.

Falmouth, Jamaica, B.W.I.,
June 15, 1888.

EFFECTS OF DIFFERENT POSITIVE METALS, &c., UPON THE CHANGES OF POTENTIAL OF VOLTAIC COUPLES.*

By Dr. G. GORE, F.R.S.

In this research numerous measurements were made, and are given in a series of tables, of the effects upon the minimum point of change of potential of a voltaic couple in distilled water (*Roy. Soc. Proc.*, June 14, 1888), and upon the changes of electromotive force attending variation of strength of its exciting liquid (*Ibid.*) obtained by varying the kind of positive and of negative metal of the couple and by employing different galvanometers. The measurements were made by the method of balance through a galvanometer, with the aid of a suitable thermo-electric pile (*Proc. Birmingham Phil. Soc.*, vol. iv., p. 130; *Electrician*, 1884, vol. xi., p. 414). The kinds of galvanometer employed were an ordinary astatic one of 100 ohms resistance and a Thomson's reflecting one of 3040 ohms resistance.

The following were the proportions of hydrochloric acid (HCl) required to change the potential of different voltaic couples in water:—

Table I.—*Hydrochloric Acid.*

		Astatic galvanometer.			
Zn+Pt ..	Between	1 in	9,300,000	and	9,388,185
Cd+Pt ..	,,	,,	574,000	,,	637,000
Mg+Pt ..	,,	,,	516,616	,,	574,000
Al+Pt ..	,,	,,	12,109	,,	15,000
		Reflecting galvanometer.			
Zn+Pt ..	Between	1 in	15,500,000	and	23,250,000
Cd+Pt ..	,,	,,	1,162,500	,,	1,550,000
Mg+Pt ..	,,	,,	775,000	,,	930,000
Al+Pt ..	,,	,,	42,568	,,	46,500

With iodine and the astatic galvanometer the following proportions were required:—

Table II.—*Iodine.*

Zn+Pt ..	Between	1 in	3,100,000	and	3,521,970
Mg+Pt ..	,,	,,	577,711	,,	643,153
Cd+Pt ..	,,	,,	200,431	,,	224,637

With bromine and the astatic galvanometer:—

Table III.—*Bromine.*

Mg+Pt ..	Between	1 in	310,000,000	and	344,444,444
Zn+Pt ..	,,	,,	77,500,000	,,	84,545,000
Cd+Pt ..	,,	,,	3,470,112	,,	3,875,000

* Abstract of a Paper read before the Royal Society, June 21, 1888.

The magnitudes of the minimum proportions of bromine required to change the potentials of the three couples in water varied directly as the atomic weights of the three positive metals.

With chlorine the following were the minimum proportions required :—

TABLE IV.—*Chlorine.*

With the reflecting galvanometer.

Mg+Pt	Between 1 in	27,062,000,000	and	32,291,000,000

With the astatic galvanometer.

Mg+Pt	Between 1 in	17,000,000,000	and	17,612,000,000
Zn+Pt	,, ,,	1,264,000,000	,,	1,300,000,000
Zn+Au	,, ,,	518,587,360	,,	550,513,022
Cd+Pt	,, ,,	8,733,585	,,	9,270,833
Zn+Cd	,, ,,	55,436	,,	76,467

In the case of chlorine as well as that of bromine the magnitudes of the minimum proportions of substance required to change the potential of magnesium-platinum, zinc-platinum, and cadmium-platinum varied directly as the atomic weights of the positive metals.

The examples contained in the paper show that the proportion of the same exciting liquid necessary to disturb the potential of a voltaic couple in water varied with each different positive or negative metal, and that the more positive or more easily corroded the positive metal, or the more negative and less easily corroded the negative one, the smaller usually was the minimum proportion of dissolved substance necessary to change the potential.

By plotting the results in all cases it was found that the order of change of potential caused by uniform change of strength of liquid varied with each positive metal.

The results also show that the degree of sensitiveness of the arrangement for detecting the minimum point of change of potential depends largely upon the kind of galvanometer employed.

As a more sensitive galvanometer enables us to detect a change of potential caused by a much smaller proportion of material, and as the proportion of substance capable of detection is smaller the greater the free chemical energy of each of the uniting bodies (*Roy. Soc. Proc.*, June 14, 1888), it is probable that the electro-motive really begins to change with the very smallest addition of the substance, and might be detected if our means of detection were sufficiently sensitive, or the free chemical energy of the uniting bodies was sufficiently strong.

ADDITIONAL NOTE ON THE RELATIVE VALUES OF THE ATOMIC WEIGHTS OF HYDROGEN AND OXYGEN.

By JOSIAH PARSONS COOKE and THEODORE WILLIAM RICHARDS.

THE preceding paper on this subject (CHEM. NEWS, vol. lviii., pp. 7, 17, 30) was already in print, and a number of the extra copies had been distributed, when the writer received a letter from Lord Rayleigh stating that he had been engaged on a similar work, and had observed that the glass balloon used in Regnault's method of weighing gas volumes, when exhausted, was sensibly condensed by the pressure of the air. Obviously, if this were true, the *tare* of the balloon thus exhausted would be too large in consequence of the lessened buoyancy of the atmosphere, and hence the subsequently observed weight of gas when the balloon was filled would be too small. A shrinkage amounting to a single cubic centimetre would make a difference of about 1·29 m.grms., and Lord Rayleigh suggested that our results might have been influenced by a constant error arising from this source. As the same balloon represented in Fig. 1 of the preceding paper had been used in all our determinations, and was still in good condition, there was no difficulty in determining the amount of shrinkage under exhaustion, and thus finding the correction which ought to be applied to the results on this account. The method we used was briefly as follows.

The balloon was first exhausted, and then completely filled with boiled distilled water at an observed temperature. The weight of this water having been taken, and the internal volume of the balloon thus determined, a small portion of the water—190 c.c.—was run out, and the volume estimated both by direct measurement and also by re-weighing the balloon. With these data we could readily calculate the volume of air left in the balloon for any given temperature, and the small amount of water lost by evaporation in the subsequent exhaustion produced no sensible effect on the result, as a knowledge of the volume within 5 c.c. was all that the present problem required, and the water did not lose in weight more than 2 grms. during the whole series of experiments.

The balloon was now thoroughly exhausted, allowed to stand, and again exhausted saveral times, until a vacuum gauge connected with it remained constant over-night, and indicated the calculated tension of aqueous vapour, which showed that all the air—dissolved or otherwise—had been practically removed.

A sufficient mass of water was left in the balloon to sink it under water, and thus immersed in a large vessel filled with distilled water (which had been boiled an allowed to cool); it was now suspended from the beam of the balance used throughout this investigation. No air bubbles formed on the glass, and care was taken to remove all entangled air from the connecting tubes. The weight soon became constant, and the tare could be accurately determined within a centigrm. The connecting tubes of the balloon were next lifted above the surface of the water, and, after carefully drying the inlet, the outside air was admitted, and the temperature of the water in the tank and the height of the barometer observed. On again immersing the balloon there was a large loss of weight—about 1·4 grms.—over six times the weight of air admitted—only about 0·2 grm. There had evidently been a marked shrinkage under exhaustion amounting to about 1·6 c.c. This decrease of weight was noted after the equilibrium had become constant, usually in about five minutes.

It is probable that the admitted air was saturated with moisture, and the calculation is based upon that assumption; but this would make no practical difference in the weight so far as the problem before us is concerned. Appended is an example of the method.

SERIES I. *Determination* 2.

Tare of globe exhausted	= 198·22 grm.	T° = 17·30°.	
,, ,, filled	= 196·83 ,,	T° = 17·30°.	
Observed loss of weight	= 1·39 ,,		
Atmospheric pressure	= 75·86 c.m.		
Tension of aqueous vapour	= 1·46 ,,		
Difference	= 74·40 ,,		
Weight of 188 c.c. moist air at 17·3° and 74·4 c.m.		0·22 grm.	
Observed loss of weight of globe		1·39 ,,	
Water displaced by difference of volume		1·61 ,,	
Diff. of. volume corresponding to 74·4 c.m. pressure		1·61 c.c.	
Do. do. 76·8 c.m.* pressure..		1·66 ,,	
Weight of 1·66 c.c. of air at 76 c.m. and 22° C.*		1·98 m.g.	

* 22° C. and 76 c.m. pressure were the average atmospheric conditions at the times of weighing the globe in the previous determinations, and 76 8 c.m. was the average difference of the pressure on the globe when exhausted and full of hydrogen.

Below are given the data of the two series of determinations which were made.

Series I.

No.	Loss of weight. Grms.	Atmos. pressure. Centims.	Temp. °C.	Correction. M.grms.
1.	1·34	76·40	18·10	1·92
2.	1·39	75·86	17·30	1·98
3.	1·39	75·80	17·32	1·98
4.	1·37	75·78	17·40	1·96
5.	1·39	75·75	17·45	1·99
				1·97

Series II.

6.	1·38	75·60	14·50	1·98
7.	1·39	75·60	14·50	2·00
8.	1·39	75·58	14·60	1·99
9.	1·40	75·58	14·61	2·01
10.	1·39	75·58	14·65	1·99
				1·99

Total average, 1·98 m.grms.

The quantity 1·98 m.grms. is then the correction sought, and this closely agrees with Lord Rayleigh's estimate of the value in the letter above referred to. Since in the work described in the preceding paper all the data required for the calculation were not recorded in every case, it will be impossible to apply this correction to each determination separately. But no sensible error can result if we add the correction to the average apparent weight of the hydrogen, easily calculated from the data given in the Table (*ante*, p. 32).

The total weight of the hydrogen burnt in the sixteen determinations as observed was 6·7029 grms. Add to this sixteen times the correction, or $16 \times 0{\cdot}00198 = 0{\cdot}0317$, and we obtain 6·7346 grms. for the corrected weight. The total weight of the water tormed was 60·1687 grms. Hence we find by difference for the total weight of oxygen consumed in the combustions 53·4341 grms.; and the corrected atomic weight of oxygen is—

$$2(53{\cdot}4341 \div 6{\cdot}7346) = 15{\cdot}869.$$

The probable error of this result is no greater than that of the "Total average" (*ante*, p. 32); for the value of the constant correction must be certainly known within the 1-50th of a m.grm. It is true that there are several variable elements which enter into the determination of this value, but they can all be estimated with far greater accuracy than the conditions of our problem require. We may therefore write as the present result of our work, H : O = 1·000 : 15·869.

Atomic weight of oxygen, $15{\cdot}869 \pm 0{\cdot}0017$.

If we compare this result with that of Dumas, as before, we have for the complete analysis of water,—

Percentage of oxygen after Dumas	$88{\cdot}864 \pm 0{\cdot}0044$
Percentage of hydrogen after final result	$11{\cdot}193 \pm 0{\cdot}0011$
	100·057

It would now appear that the close agreement before shown was a mere coincidence, and that there must have been a small constant error either in our own process or in that of Dumas. Where the error lies further investigation can alone determine; for although, after a careful revision of our work, we can discover no flaw, no one can be confident that such a constant error as has already appeared may not hereafter be found, and certainly can only be secured after repeated confirmations by essentially different methods. While, therefore, we feel bound to acknowledge without delay the cause of constant error which Lord Rayleigh has pointed out, we give our corrected result as subject to further revision. It has been suggested by Lord Rayleigh, in a "Preliminary Notice" of his work on the relative densities of hydrogen and oxygen, of which advance sheets have been received while writing this note, that in our combustions the hydrogen may have been imperfectly burnt, especially as towards the last of the combustion it must have been greatly diluted (but with air). We have no decisive evidence on this point; but the whole course of our combustions assured us that this could not be the case. Duping the first stage of the combustion, when pure hydrogen was passing into the combustion tube, and while water was dropping into the condenser (Fig. 4), there would often be several minutes—during which the larger part of the water was condensed—when no residual gas whatever would be seen to escape, and the bubbling of the gas through the sulphuric acid at the bend of the U-tube made the least overflow perfectly evident. Again, the oxide of copper in the combustion tube was always reduced to a perfectly definite limit, leaving at least seven-eighths of the tube in which the black oxide was apparently wholly unchanged. Further, it is not probable that an error arising from the imperfect combustion of the hydrogen would have a constant value. The unconsumed residue must vary greatly with the conditions of the experiment; and such an agreement as that exhibited by the results could never have been obtained under such circumstances.

It seems unnecessary to add that every precaution was taken in our work which our experience could suggest, and that a great amount of labour was spent on such details which does not appear in the published results. Both the balances and weights employed were most carefully verified. The water formed by the combustion was tested, and the dissolved air taken into account. We mention these points because they have been noticed by correspondents; but many similar details which were worked out and set one side we have not thought it necessary to describe in our paper. In writing such a paper elementary principles must be assumed.

In adopting Regnault's method for weighing the hydrogen used in our determinations, we assumed with him that the glass balloon used in the work remained practically constant, whether exhausted or filled with gas. We never questioned this assumption, not only because we had the greatest confidence in all Regnault's work, but also because we knew that he had himself carefully investigated the behaviour of glass bulbs under pressure; and indeed he treats the subject fully in the paper immediately preceding his classical paper on gas density.* Moreover, we made with our apparatus a preliminary determination of the density of air, and obtained Regnault's number within the limits of the uncertainty in regard to the value of the force or gravity at this place. Regnault's values for the weight of 1 litre, not only of air, but also of nitrogen, oxygen, hydrogen, and carbonic dioxide, have been hitherto regarded as among the most trustworthy data of science. His determinations were all made by the method of counterpoise which we adopted in our work, and he used balloons of twice the volume of those we employed. When exhausted, the glass must have been condensed to an even greater extent than has been shown above; but no account whatever is taken of this shrinkage. As Regnault's constants have been universally used, it is obvious that Lord Rayleigh's correction must be applied to all determinations of gas or vapour densities hitherto made, and to all atomic weight determinations of any kind which involve the calculation of the weight of a measured volume of any gas or vapour. Except, however, in the case of hydrogen, the correction will be inconsiderable.—*Proc. Amer. Acad. of Arts and Sciences.*

A New Double Potassium and Sodium Carbonate.—L. Hugounenq and J. Morel.—The salt in question is a compound of double sodium-potassium carbonate and of sodium carbonate, each salt being combined with 6 mols of water.—*Bull. de la Soc. Chim. de Paris*, Vol. xlix., No. 9.

* *Mémoires de l'Acad. Roy. des Sciences de l'Inst. de France*, vol. xxi., pp. 106 and 121.

THE LABORATORY DRYING OVEN.

By A. J. BANKS.

In laboratories where steam is used for the purpose of heating drying ovens, evaporating pans, &c., the water produced by the condensation of the steam is a frequent and troublesome annoyance. The supply pipes very often have to be carried a considerable distance before reaching the laboratory, and are, not unfrequently, exposed to strong draughts of air; hence, considerable condensation of the steam is brought about, and in conjunction with that produced by the expansion of the steam on entering

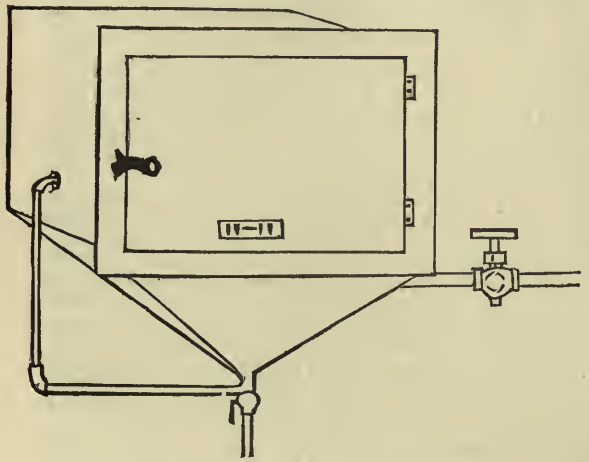

Fig. 1.

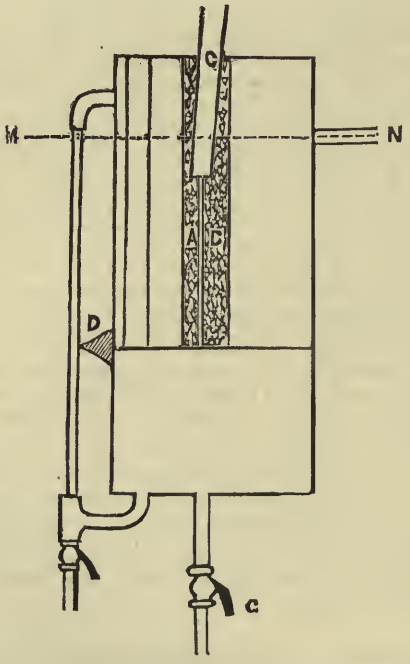

Fig. 2.

the oven, and the larger surface there exposed, the amount of water produced is a serious obstacle to the attainment of high temperatures.

With the object of overcoming this difficulty I have devised a modified form of water oven, which answers admirably. Its construction will be readily understood from the accompanying drawing, which represents an ordinary drying oven with the bottom of the outer covering in the form of an inverted pyramid, provided with a gauge glass to indicate the height of the water, and a stopcock or valve for running off the same. The inlet pipe is placed immediately below the inner case, Fig. 1.

Where ovens of the ordinary flat bottom form are already fitted in the laboratory and supplied with steam a great deal of heat may be saved by passing the steam through a water separator immediately before entering the oven. By this means a large quantity of water held in suspension by the steam is removed.

I have lately had a water separator made according to my design, which I find answers this purpose very well. It consists of a copper cylinder 9 inches long, 4 inches diameter, and 1-16th inch thick, provided with a perforated diaphragm 3 inches from the bottom, to which five upright pieces of perforated copper plate are fastened, their upper ends being secured to the top of the cylinder. The central pieces, A, B, are each $1\frac{1}{2}$ inches × 6 inches, and bent at an angle of 45°, so that the exhaust pipe, C, is surrounded by perforated plates. The remaining three plates are $\frac{3}{4}$ inch × 6 inches, and are inclined at an angle of 45°, with the diameters of the cylinder cutting each other at right angles, as shown in the section taken through M, N, Fig. 3. The inlet pipe is $\frac{1}{4}$ inch internal diameter, and is

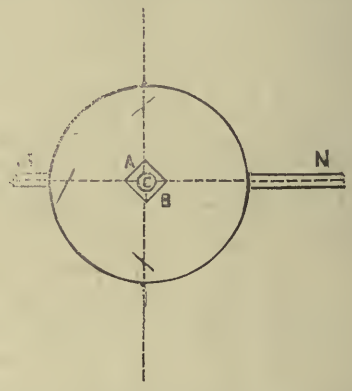

Fig. 3.

placed 2 inches from the top of the cylinder; the exhaust pipe has the same bore, and reaches 3 inches from the top. The gauge glass is of the usual form, provided with protection plates and a stopcock. A fixed indicator, D, shows the position of the diaphragm, above which the water should not be allowed to rise. The separated water may be drawn off by means of the stopcock, G, which may be so regulated that a constant level is maintained in the cylinder.

The drawings are not drawn to scale.

Fairfield, Liverpool.

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on a

PROBABLE ORTHO-QUINONE DERIVED FROM ANTHRAQUINONE.

Preliminary Note.

By W. H. RICHARDSON.

Recently valuable additions have been made to our knowledge of the quinones, and a large share of the investigations in this direction we owe to Prof. Zincke and his students. One of the latest achievements in the Marburg Laboratory has been the preparation of derivatives of ortho-benzoquinone, a body hitherto unknown. By oxidation of tetra-brom- and tetra-chlor-pyrocatechine,

Zincke obtained the corresponding halogen ortho-quinones, and has furthermore shown that tetra-brom-ortho-benzoquinone is identical with the body described by Stenhouse as erythro-brom-pyrocatechine. With the hope of obtaining an ortho-quinone of the anthracene series, I have studied the action of various oxidising agents on alizarin, which may be regarded as the hydroquinone of a di-quinone—

$$C_6H_4<^{CO}_{CO}>C_6H_2O_2,$$

which hypothetical body contains quinone groups in the para- and ortho-positions.

Oxidation in acid solution does not produce the desired effect; alkaline solutions of alizarin, however, are easily oxidised by the usual agents, but the best results are obtained by permanganate or bromine. The best conditions of experimenting have as yet not been determined, and I will defer the description of the actual oxidation until this has been done.

The alkaline solution containing a mixture of substances is acidified, whereby a fawn-coloured precipitate is produced. This precipitate I regard as a quinone or an ortho-diketone corresponding to alizarin, and for this assumption the following reactions may be adduced:—

(1). By reduction in acid solution alizarin is reproduced.
(2). Phenylhydrazine and its sulphonic acid produce characteristic substances, which are dye-stuffs; this speaks for the presence of two (CO) groups in the ortho-position (Fischer).
(3). With aniline an anilide is formed.
(4). The solution of the compound reacts easily with ortho-diamines (tri-amido-benzene and ortho-naphthylene-diamine-sulphonic acid).

The filtrate from this precipitate contains phthalic acid, which was recognised by conversion into fluoresceïn, and by the analysis of its barium salt.

Against the assumption that such a simple product of oxidation has been formed, the researches of Henriques may be quoted. He has shown that the naphthyl ring is destroyed by alkaline permanganate, benzene derivatives being formed, but further examination will show the real constitution of the body, and I have only published this note in order that I may secure the subject for complete investigation, and I hope before long to be able to give an exact description of this new compound and its derivatives.

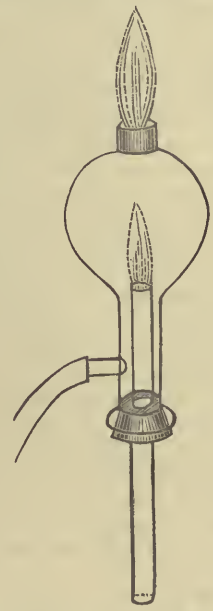
Southowram, Halifax,
July 10, 1888.

LECTURE APPARATUS FOR SHOWING COMBUSTION OF AIR IN AN ATMOSTHERE OF COAL-GAS.

By GEORGE CRAIG.

The accompanying sketch represents a more simple and convenient form of apparatus than those in vogue for showing the combustion of air in an atmosphere of coal-gas, or other instances of a similar nature. It consists of a flask (6 inches in diameter) with a side tube on the neck for supplying the coal-gas, and with an orifice at the bottom, which is lined with asbestos, to act as a burner, and preserve the glass from cracking. The mouth of the flask is fitted with an india-rubber cork, the perforation through which is lined with ordinary cork well soaked in vaseline to make an air-tight joint and yet allow the glass tube (½ inch diameter) to move easily up and down.

To carry out the experiment, the glass tube is raised until it just projects through the orifice, the gas is turned on, and the apparatus inverted so as to fill it by displacement. When a strong smell of gas is perceived at the orifice the issuing gas is lighted, and the apparatus restored to its original position. Caused by the draught of the flame, a current of air is drawn up the central tube, and of course burns along with the gas at the orifice. By simply lowering the glass tube the almost non-luminous air-flame may be shown burning in the interior of the globe. It is desirable to heat the flask gently before performing the



experiment, to prevent any subsequent deposition of moisture. When it is desired to stop the experiment the supply of gas is simply shut off, when the two flames, after a short time, go out *quietly*.

In exactly the same manner oxygen or chlorine may be shown burning in hydrogen gas.

The apparatus may be obtained from Messrs. Baird and Tatlock, Crown Buildings, Glasgow.

Lugar Iron Works Laboratory,
Ayrshire, N.B.

FURTHER INVESTIGATION ON THE ATOMIC WEIGHT OF COPPER.*

By THEODORE WILLIAM RICHARDS.

In vol. xxii. of the *Proceedings of the American Academy of Arts and Sciences* there appeared a description of a new determination of the atomic weight of copper, based upon the precipitation of silver from a neutral solution of argentic nitrate by pure metallic copper. In the course of some further experiments it became necessary to ignite a portion of the silver from determination No. 5 of that series; and it was found that two grms. of silver lost four-tenths of a milligrm. by this process. It is thus evident that 150° is not a temperature high enough to drive out all the water from the silver, and hence the results before given are incorrect by a slight amount. In this determination the weight of the silver was 3·39035 grms. after drying at 150°, hence its weight after ignition would have been 3·38975 grms. The weight of copper taken was 0·9987 grms., therefore the corrected atomic weight of copper would be 63·452 instead of 63·437.

* Contributions from the Chemical Laboratory of Harvard College. From the *Proceedings of the American Academy of Arts and Sciences*, vol. xxiii.

Unfortunately, all the silver formed in the other determinations had been employed in testing for the presence of copper; hence it was impossible to determine whether the other samples would lose water on heating in a similar manner. It seemed, therefore, desirable to make a new series, using samples of pure copper, prepared from the ores of different localities. Should the result be the same in each instance we should have a very strong proof, not only that the copper used in each case was pure—because the different samples would probably contain different impurities—but also that the atomic weight of copper is a perfectly constant quantity.

The method used was exactly that of the previous paper, although more difficulty was found in keeping the solution below zero for twenty-four hours than was the case before, because of the warmer weather. Several determinations had to be rejected because the temperature rose above zero, and copper was precipitated with the silver. Upon splitting open the fine crystalline plates of silver precipitated in these rejected experiments, a light-green precipitate of basic cupric nitrate was found adhering to the inner surface, which could not be removed by continued washing with cold water. The presence of this precipitate explains the admixture of copper with the silver precipitated above zero, and points at once to the mechanism of the chemical action.

When copper is placed in a solution of argentic nitrate, two reactions take place, and the temperature regulates the predominance of one or the other. The chief reaction is the simple one ordinarily written; it alone is active between 0° and 5°, and it is the chief one even at 100°. The secondary reaction, which is active at 100° but which entirely ceases below 0°, may perhaps be written thus—assuming that the basic nitrate has the formula usually assigned to it:—

$$4AgNO_3+4Cu+3H_2O= \\ =Cu(NO_3)_2{\cdot}3Cu(OH)_2+2Ag_2+NO+NO_2.$$

Evidently in this reaction the copper precipitates only one-half of its equivalent of silver. It will be remembered that an evolution of nitrous fumes was previously observed when the temperature rose above the freezing-point.

The argentic nitrate used in the new series, was pre-prepared as before, except that even greater precautions were taken to insure its purity by successive crystallisations and fusions.

Two samples of copper were used, one from Lake Superior, the other from Germany. For the purification of the former the sample was dissolved in sulphuric acid, with the addition of nitric acid; the solution was evaporated to dryness, and the solid heated over asbestos in a porcelain dish until the fumes of sulphuric acid ceased coming off. The cupric sulphate was now dissolved in water, crystallised twice, and the diluted solution of the last crystals boiled and shaken with a little potassic hydrate for three hours. The solution was now filtered, and the cupric sulphate was crystallised several times from hot water. Finally, the solution of the last pure crystals, strongly acidified by sulphuric and a little nitric acid, was decomposed by the current of a Bunsen cell, and the chemically pure copper deposited on thick platinum foil.

The second example of copper was prepared from German cupric oxide in a similar manner except that the sulphate was crystallised a greater number of times. In this connection it may be mentioned that, of many samples of German cupric oxide tested, not one was found which did not contain a comparatively large amount of arsenic. In the case of many samples, after several reductions with pure hydrogen and oxidations, the arsenic will actually sublime off as arsenious oxide; and a quantity of the substance was collected in this manner.

The method of cleaning the copper was similar to that previously adopted; it was treated in succession with dilute potassic hydrate, dilute sulphuric acid, and a very large amount of water, and then dried and reduced by pure hydrogen.

The silver which was obtained by precipitation from the pure argentic nitrate was first washed and dried at 150°, and weighed as before; and was then heated to incipient redness, and weighed again. The loss of weight by this process varied with the different samples between three-tenths of a milligrm. and one milligrm. The Gooch crucible and asbestos mat subjected to the same treatment did not lose an appreciable quantity. The results were calculated for the weight of silver both before and after ignition, and it will be noticed that the first column of results corresponds almost exactly to the results given in the previous paper. The silver was in each case tested for copper, and no trace was found.

The average of these two series is 63·450, with greatest variations of +0·002 and −0·003, and a probable error of ±0·0006. The average of the results calculated from the weight of silver dried at 150° is 63·436, while the results published in the preceding paper gave 63·437.

The complete concordance of these results with each other, and with the previous value above referred to, would point strongly to the following conclusions:—

First, that the copper used in each case was absolutely free from metallic alloy; for manifestly, the three entirely different samples would be likely to contain different impurities, or at least different amounts of the same impurity. The copper was tested for sulphur with the greatest care by solution in nitric acid and treatment with baric chloride, and no trace of cloudiness was perceptible. That the copper was *absolutely* free from impurity is not contended; only, that it did not contain a weighable amount of impurity in one grm., the amount used in each experiment. It is manifest that attempts to purify the copper beyond this limit would be labour thrown away, and would produce no effect upon the

RESULTS.

German Copper.

No. of Experiment.	Weight Cu.	Weight of Silver formed. Before Ignition.	After Ignition.	Cu : Ag_2=1 : *n*.	Atomic Weight Cu (Ag=107·675). Before Ignition.	After Ignition.
	Grms.	Grms.	Grms.			
1	0·75760	2·5723	2·5713	3·3940	63·426	63·450
2	0·95040	3·2261	3·2256	3·3939	63·440	63·451
3	0·75993	2·5798	2·5794	3·3942	63·438	63·447
						Average, 63·449

Greatest variation = ±0·002. Probable error = ±0·0010.

Lake Superior Copper.

4	1·02060	3·4650	3·4640	3·3942	63·432	63·448
5	0·90460	3·0705	3·0701	3·3939	63·444	63·452
						Average, 63·450

Greatest variation = ±0·002. Probable error = ±0·0013

atomic weight. For example, one-tenth of a milligrm. is a very large amount of foreign material to suppose existing in a grm. of copper purified with such care; but this large amount would only change the atomic weight five units in the third decimal place—a quantity which is of no consequence when the atomic weight is in doubt three units in the first decimal place.

Another and still more positive conclusion reached by these results is that the atomic weight of copper is a constant quantity with reference to nitric acid and silver. If copper had a variable atomic weight it would surely appear in specimens taken from such widely different sources. This conclusion still remains in force, even supposing there be a constant error in the process, for the constant error must affect all the results equally, and could not possibly equalise unlike results.

A third conclusion, pointed out by the determinations, is that the argentic nitrate was the normal compound, and quite pure; for it will be remembered that two entirely different samples had been used in the course of the work.

There is but one point which remains to be considered, and that is the existence or non-existence of a constant error in the reaction. That this is by far the most important point in the whole discussion it is unnecessary to state. Whether there be such a constant error future investigations may show; for the present, it is sufficient to say that it is extremely difficult to see where such an error might creep in. The whole reaction is so simple and so sharp that the probability of error is reduced to a minimum, and in every case any possible cause of error has been guarded against.

Professor Cooke, under whose direction the whole investigation has been conducted, suggested that similar experiments be made, using argentic sulphate instead of the nitrate; but after a large number of trials this was found to be impracticable: first, because the solution has a much higher freezing-point than that of the nitrate; and secondly, because the solution was necessarily so dilute on account of the slight solubility of argentic sulphate, that the complete precipitation of the silver required a much longer time, giving more opportunity for secondary reactions. The silver was always accompanied by a very slight admixture of some basic cupric sulphate; and hence this method, which, if successful, would have been able to throw much light on the question of a constant error in the previous results, had to be abandoned.

NOTICES OF BOOKS.

The Laboratory Guide; a Manual of Practical Chemistry for Colleges and Schools, specially arranged for Agricultural Students. By A. H. Church, M.A., F.R.S. Sixth Edition, Revised and Enlarged. London: Gurney and Jackson (late Van Voorst).

When a work has passed successfully through the ordeal of six editions, and is still regarded with approval by competent judges, the task of the reviewer is to a great extent anticipated. The "Laboratory Guide," however, has grown from 174 pages to 286, and contains not a few emendations and additions which it may be useful to point out.

Thus we now find introduced the methods of Ruffle and of Kjeldahl for the determination of nitrogen. In the analysis of milk the method of Adams is recommended where a strict determination of fatty matter is aimed at. For the estimation of fats in butter we have the processes of Kœttstorfer, the "rapid" saponification, Reichert's and Hehner's method.

For the determination of the true albumenoids Mr. Church gives the preference to the phenol method as against the tannic, the ferric acetate, and the lead acetate processes.

The analysis of water is explained at considerable length, it being, however, pointed out that gas analysis and the search for rare constituents do not fall within the scope of the work. The determination of nitrogenous organic matter is given according to the Wanklyn, Chapman, and Smith process. The author directs the amounts of ammonia obtained to be entered as albumenoid ammonia, a term which, though inexact, is generally understood.

A brief notice is given of the "biological test" for waters, of the value of which the author seems doubtful.

In the separation of iron and aluminium in soils, coprolites, &c., the author determines the iron volumetrically, and deducts its calculated quantity from the joint weight of the two bases. It would have been interesting to see his opinion on the new trimethylamine process.

We notice with satisfaction the introductory remark that, though the facts and the laws of chemistry are the same for all students, yet they may and should be illustrated in a different manner, according to the objects which different classes of students have in view. Thus the agricultural student "would have the laws of diffusion illustrated to him by the processes which go on in the soil and in the plant; the medical student, on the other hand, would study the same laws as they work in the liquids and gases concerned in the functions of the human body." Thus the study of chemistry may be made, at the same time, both general and special.

The "Laboratory Guide" is in no danger of losing its pre-eminence as the most suitable manual for agricultural students.

The Manufacture of Potassium Chlorate and other Chlorates. ("Die Fabrikation von Chlorsaurem Kali und anderen Chloraten.") By K. W. Jurisch, Ph.D., Privat Docent in the Royal Technical High School of Berlin. Berlin: R. Gaertner.

The author of this useful work has evidently a thorough acquaintance, practical and theoretical, with his subject, and he expounds the results of his experience in a very clear and comprehensive manner. In the first section we find a general notice of the history of potassium chlorate, its properties, its industrial applications, formation, and preparation.

According to Kopp this compound has been obtained as far back as the 17th century, though it was then confounded with saltpetre. Berthollet first recognised its nature and composition in 1786 to 1788., or, according to one authority, as early as 1785. The first indications for its preparation on a commercial scale were due to Liebig.

The decomposition of potassium chlorate by heat has been the subject of no little research. It has been generally observed that the gas given off on heating the chlorate, whether alone or along with manganese, is contaminated with chlorine, and that the residue contains, along with potassium chloride, a little potassium oxide. This latter fact was ascribed by some authorities to the presence of a small impurity of potassium nitrate. Vulpius, however, showed that even in the total absence of nitrates the residue has an alkaline reaction. L. Scholvien, who has made a thorough investigation of this question, suggests that there is formed during the fusion of potassium chlorate a lower combination of chlorine and oxygen.

The poisonous character of potassium chlorate is brought into prominence. The corresponding sodium salt is so much less dangerous that the poisonous character of the potassium salt is ascribed to the general nature of the potassium salts rather than to the specific action of chloric acid.

The modern methods for its manufacture are developments of the original process devised by Liebig, which consists in first preparing a solution of calcium chlorate, which is then decomposed by potassium chloride.

In the second chapter we find a detailed description of

the apparatus and of the progress of the manufacture, illustrated with designs drawn to scale. Certain modifications are involved, according as the supply of chlorine gas is obtained by the Weldon or the Hurter-Deacon process.

We notice with pleasure that the author in giving the densities of liquids in degrees Twaddel, explains for the benefit of his countrymen how readily these degrees are translated into the corresponding degrees of direct specific gravity,—an advantage which the scale of Beaumé is very far from possessing.

The following chapter, the chemical investigation of the process, opens with analyses of the raw materials and a statement of their cost. For the chlorine gas prepared on Weldon's process the author admits an average strength of 25 per cent by volume, whilst the Hurter-Deacon gas ranged between 3 and 11 vols. per cent. But into the particulars of this admirably elaborated section space does not allow us to enter.

A technical and economical criticism of the manufacture comes next. The author points out that chlorine and potassium chloride being the costliest materials, their full utilisation is a question of prime moment. Fuel comes only in the second rank, whilst labour, repairs, and lime are relatively unimportant items. The theoretical yield of chlorate is 148 parts per 100 parts of potassium chloride at 90 per cent. The average of the years 1873-76, however, did not exceed 104·7 per cent. In the years 1877-80 the proportion rose to 110·1 per cent. Dr. Jurisch finds that in the consumption of acid the Deacon process has a decided advantage over that of Weldon.

The production cost per ton chlorate in England the author calculates at £31 4s. 10d. by the Weldon process and £28 3s. 4d. by the Hurter-Deacon. In Germany the cost of the Weldon process is greater than in England, but by the Hurter-Deacon method it is calculated as less by one-fourth. In Germany it appears more advantageous to convert the hydrochloric acid into potassium chlorate than to sell it as such.

The remaining chapters discuss the magnesia process (which yields a better return than the lime process per 100 parts of potassium chloride consumed, but which encounters collateral difficulties), the manufactures of sodium, lithium, and barium chlorate, and finally the statistics of the manufacture.

The appearance of this work is an important and most welcome addition to the technology of our greater chemical industries.

National Association for the Promotion of Technical Education. Address delivered by the Earl of Rosebery at the Opening of the New Wing of the Keighley Institute.

Slöjd; A Lesson from Sweden.

Birmingham, Briage Street, Seventh Standard Technical School.

Technical Education for Employers and Managers.

The Lesson of Commercial Competition.

Commercial Education and our Higher Schools.

Commercial Progress and Secondary Education.

Are the Elementary School Standards the End or the Beginning?

The Need of Evening Schools.

Manual Training in Schools. Drawing in Elementary Schools.

Handy Hands and Observing Eyes.

Technical Training and Watch-Making.

Long Hours v. *Short Hours.*

Technical Education from a Working Man's Point of View.

Is Technical Education a Device of Employers?

A Working Mechanic's View of Industrial Education.

A Workman's Wants.

Is Technical Education for the Many or the Few?

Our Neighbours and Ourselves.

A Question for Parents. What is Technical Education?

A Question for Employers.

That our national industrial position in these days is unsatisfactory needs no demonstration. That our system of education, if system it may be called, is inferior to that of many countries, and especially of those nations which are our chief rivals, is also admitted by all who can judge the tree by its fruits. And there is a growing conviction that the second of these shortcomings is largely responsible for the first. In this feeling we must avow our conviction that a great part of the assertions and the arguments to be found in the pamphlets and leaflets above mentioned are true and cogent, and that they earnestly call for practical attention. The writers in question do nowhere allege that our defective or unpractical education is the sole cause of industrial depression. They admit that our manufacturers and merchants have been too little heedful of the wants of their customers, that they have insisted too stringently upon larger profits and short credits, and, in short, have gone on the "take it or leave it" principle, thus allowing their foreign competitors to introduce the thin end of the wedge. They further concede that our commercial travellers and agents have been less willing or less able to ingratiate themselves with the people with whom they have to do business.

The writers in question, however, make no mention of our defective patent laws, which allow an alien to uphold a British patent without even working it on British ground, whilst a British subject obtaining a patent abroad loses it unless he works it abroad. The regrettable fact that so many alien clerks, foremen, &c., are employed in British manufactures is due not solely to any superiority on their part, but to causes which to expound would involve a digression.

But the real question now before us is what are we to do to bring up our technical and scientific education at least to the level of our neighbours? Additional expenditure and additional taxation will not of necessity effect the end desired. A cripple in the right road will beat the fleetest racer in the wrong one, all whipping and spurring notwithstanding. Now are we in the right road, or are we about to get into it? One only of the leaflets before us seems to touch upon this phase of the subject at all. The author of "Handy Hands and Observing Eyes" notices, in a very modest and quiet manner, the absence in our education—high class and low class alike—of any systematic culture of the faculty of observation. He declares our present system a "mere routine of reading and memory," and demands something "less bookish and more intelligent." But in not one of these documents is there any reference to the main difference between our modern British educational system and that which prevails, *e.g.*, in Germany. This difference lies in our unhappy notion of "payment by results" and in our ever-recurring examinations. Here, we believe, is the root of our inferiority. The properties which come to the front in an examination—verbal memory, the power of reproducing what has been swallowed in authorised language—are precisely the properties which do not lead to success in practical life, still less to eminence in Science. No examiner can test the power of a student to observe accurately and searchingly and to draw correct conclusions from the phenomena observed. Consequently our system favours and produces talkers rather than workers.

One of the writers whose works lie before us protests against blindly following foreign systems, unsuited to our national conditions. But is not competitive examination a blind following of the Chinese, among whom its unhappy results may be plainly seen in general stagnation?

In the pamphlets before us, as well as in the Bill on Technical Education which Parliament will before long

have to discuss, we see no indications of any improvement. For anything we can see to the contrary payment by (pseudo) results, examinations, and cram will flourish in the technical schools. The teaching will be under the management of the School Boards, bodies generally composed of the nominees of the religious denominations or of the political factions in each district. Nor is it free from the influence of the Department of Science and Art, a body to which we object, amongst other reasons because it is to a great extent, and we believe in virtue of a statute in the lands of military men. The main task of the true educator is to develope the powers of every mind coming under his charge, each in its own direction. But the main task of the military man is to reduce everything to one uniform, stereotyped pattern. It provokes a smile on the Continent that the nation which entrusts its army and navy to the management of civilians should, in return, place its schemes for higher education in the hands of soldiers.

CORRESPONDENCE.

ON THE COLORIMETRIC DETERMINATION OF SULPHUR IN IRON AND STEEL.

To the Editor of the Chemical News.

Sir,—In the Chemical News (vol. lviii., p. 41) there appears an article by Arnold and Hardy, on "New Methods for the Estimation of Sulphur in Iron and Steel-making Iron," in which the authors give their experience of Parry's colorimetric method described by me (Chemical News, vol. lvi., p. 13), which is to the effect that "under the prescribed conditions the colour" obtained (say from a steel containing 0·03 per cent S) "is a very decided *precipitate*, and that consequently accurate comparison is impossible."

Speaking from personal experience, extending over a period of two years (during which time I have employed Parry's colorimetric method for the determination of S in iron and steel, ranging from as low as 0·02 to as high as 0·20 per cent and over), I have found the method to give very concordant and good results, as proved by their agreeing, within experimental error, with those obtained by independent chemists and the Barium Chloride method.

The precipitate obtained by Arnold and Hardy in working the method may be due to one or more of the following causes, viz.,—

(A) The lead acetate solution employed was too strong.

(B) The cylinder containing the acetate solution became heated.

(C) The acetate solution, after evolution of gas had ceased, was allowed to remain for too long a period before comparison.

It is true that with careless manipulation a precipitate is formed, but with the strict observance of the above precautions, and above all *practice*, this is prevented.

Concerning the colorimetric method described by Arnold and Hardy, I am of opinion that it is nothing more or less than a *modification of Parry's colorimetric method* described by me. Practically, therefore, Parry has the *prior* claim of having *first* adapted the employment of a lead acetate solution as the basis of a colorimetric method. But he informs me that he considered it merely a modification of Frankland's method for the determination of lead in water. It is therefore, strictly speaking, not a *new process* in the ordinary sense of the word. And further, that he considered it hardly worth publishing, as any chemist may work out such a modification.—I am, &c.,

J. Jas. Morgan.

The Laboratory, Ebbw Vale,
July 31, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of emperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 3, July 16, 1888.

Observations on the Recent Communications of M. Sabatier on Hydrochloric Copper Chloride and on Hydrochloric Cobalt Chloride.—M. Engel.—The author complains that although M. Sabatier admits his priority, yet that he has erroneously sought to explain the discrepancy between his formula and that of M. Engel by asserting that the latter had analysed a partially decomposed specimen.

The Elementary Composition of Crystalline Strophantine, extracted from Strophantus Kombé.—M. Arnaud.—The composition of strophantine is $C_{31}H_{48}O_{12}$, and it appears, therefore, as the next higher homologue of ouabaine, $C_{30}H_{46}O_{12}$. These two substances, both free from nitrogen, seem to have in their constitution a common central nucleus, which is perhaps the same with an entire series of heart poisons.

Influence of the Temperature of Fermentation on the Production of the Higher Alcohols.—L. Lindet.—The proportions of the higher alcohols are substantially the same at different temperatures.

Bulletin de la Société Chimique de Paris. Vol. xlix., No. 9.

On the Metapyrazolones of Pinner and Lifschütz.—Ed. Grimaux.—The alleged metapyrazolone is the body generally known under the names glycol-urea or hydantoine.

Preparation of Hydriodic Acid.—A. Etard.—The author proposes the use of a new apparatus, which is here figured.

Researches on the Optical Isomers of Cinchonine—E. Jungfleisch and E. Léger.—The authors explain a treatment based upon a very small number of facts: the separation of the bases respectively soluble and insoluble in ether. In the soluble bases, separation of cinchonigine as hydrochlorate and of cinchoniline as dihydriodate. Among the insoluble bases there is effected a separation of the oxycinchonines based upon their solubility in weak alcohol, and of cinchonibine as succinate, and of conchonifine as hydriodate.

A Pseudomorphosism of Acerdese. Artificial Production of Pyrolusite.—A. Gorgen.—The nature of this paper appears sufficiently from the title.

Researches on Phosphorescent Hexagonal Blende.—A. Verneuil.—Already noticed.

On Nitro-nitroso-resorcine.—M. de la Harpe and F. Reverdin.—This compound is obtained by introducing gradually a refrigerated mixture of 1 mol. nitro-resorcine, 1 mol. caustic soda dissolved in 10 parts of water, and 1 mol. sodium nitrite in aqueous solution into an excess of dilute refrigerated sulphuric acid. Yellow flocks are precipitated, having the composition—

$$C_6H_2(NO)(NO_2)(OH)_2.$$

No. 10.

On Chydrazine or Ammonia Protoxide.—E. J. Maumené.—(To the name of this compound is appended the note:—"Pronounce *ci*; *c* signifies 3 equivalents of hydrogen"). The normal action of ammonium oxalate and permanganic acid may be easily obtained by bringing equal weights of the two bodies into contact. He takes, however, 111 grms. of the oxalate, 158 grms. of potassium

manganate, and 40 of SO_3. These ingredients are mixed in the author's "mixer" ("melangeur"). The acid to be combined with the "chydrazine" is placed in the receiver.

Separation of Calcium from Barium and Strontium.—Professor Kupfferschlæger.—The author, after criticising other methods, describes his own process. The mixture of calcium, barium, and strontium carbonate is treated with very dilute nitric acid and evaporated to dryness. The residue is taken up in pure water, and the solution, filtered and quite neutral, is evaporated to complete dryness. The three nitrates which constitute this product are successively exhausted by four successive small portions of absolute alcohol, each time a little more ethereal than the former. This is done in a small well-stoppered flask, which is often shaken, the solutions are filtered after standing long enough to become clear, not longer. When the last portion of ethereal alcohol leaves nothing on spontaneous evaporation the calcium nitrate is separated from the two others. These, after being well dried, are dissolved in water and to the solution placed in a small tall narrow glass is added solution of potassium dichromate, saturated in the cold; in this manner the barium is thrown down on chromate. The precipitate, after washing with water containing a little alcohol, is then heated with sulphuric acid to convert it into barium sulphate. The liquid containing the strontium is mixed with dilute sulphuric acid and heating moderately, so as to throw down the strontium sulphate.

The Purification of Mercury.—J. M. Crafts.—The author effects the purification by passing air through the mercury for forty-eight hours. The impurities, zinc, lead, tin, &c., collect at the top of the tube in the form of a black powder. The removal of traces of silver and gold is not necessary for mercury intended for filling barometers and similar instruments. These impurities do not affect the density of the mercury, nor alter the appearance of the meniscus. The author considers that if pure air has any oxidising action upon pure mercury it is so slight as to be scarcely appreciable. Platinum in thin foil is not attacked by mercury in the cold, but on prolonged boiling the platinum is attacked, the greater part remaining in suspension as a black powder.

The Resistance to Light of Colouring-matters fixed upon Tissues.—Jules Joffre.—The author proposes methods of testing the permanence of dyed tissues on exposure to light. The methods employed, the precautions to be taken, and the fact that the action of light is intensified by moisture, are not unknown to colourists.

Composition and Combustion-heat of Coal of the North of France.—M. Scheurer-Lestner.—The author's results are given in the form of tables.

Chlorine and Cyanogen.—E. Allary.—Dumas, in one of his most interesting memoirs, resolved the atomic weight of chlorine into a polynome of the following form. $Cl = 35{\cdot}5 = 19 + 16{\cdot}5$. The author has arrived at the same point by setting out from a different point of view, the isomorphism of potassium chloride and cyanide. He suggests that chlorine may be a compound of fluorine and oxygen, perhaps intimately united to H/2.

Zeitschrift fur Analytische Chemie.
Vol. xxvii., Part 1.

Detection of Fusel in Spirits.—Uffelmann (*Zeitschrift für Hygiene*), pours 250 c.c. of the spirit into a ¾ litre flask, adds 100 c.c. of ether, shakes up well, adds sufficient water to separate the ether, draws off the ethereal liquid, shakes up afresh with 100 c.c. ether, unites the ethereal extracts, lets evaporate, dissolves the residue in 40 c.c. ether, adds a few c.c. of fresh green solution of methyl violet (dissolve 1 part methyl-violet in 100 water and add hydrochloric acid at 2 per cent until the liquid turns green), shakes, and pours into a graduated tube, 2·5 c.m. in diameter. The ether evaporates. As soon as a blue colour is perceived and the first indication of the methyl-violet absorption at D is detected with the spectroscope, he reads off the quantity of ether still remaining. Each 10 c.c. of the liquid contain 0·2 c.c. amylic alcohol, which occasions the blue colour.

Distinction between Horse-flesh and Ox-flesh.—James Bell.—From the Chemical News.

On Cacao and its Preparations.—P. Zipperer.—A prize essay, the particulars of which are not given.

Analysis of the Peptones.—Guido Bodländer.—This paper does not admit of a useful abstraction.

Examination of Peptonising Ferments.—E. Geisler and A. Kremel.—For the contents of this memoir we must also refer to the original, or to the *Pharmaceut. Central-Halle* and the *Pharm. Post.*

Determination of Carbonic Acid in Inhabited Rooms.—R. B. Warder.—From *Annual Report of State Board of Health of Indiana.*

Bacteriological Examination of Soils.—C. Fränkel.—This memoir does not admit of useful abridgment, and the reader is therefore referred either to the *Zeitschrift* or to the *Zeitschrift für Hygiene.*

Chemical Test for Cholera Bacteria.—Bujwid has recently referred to the colour of the culture-liquids on admixture with hydrochloric acid. Dunham remarked that the presence of peptone in the culture liquid was essential for the success of the reaction. Josef Judassohn now states that the cholera-red reaction is obtained in culture liquids free from peptone, and that an abundant growth of cholera-spirilla may exist, though the reaction does not succed. Purity of the culture and an abundant supply of oxygen are needed to produce the cholera-red. F. Cahen takes the suspected colonies from a plate-culture, puts them in alkaline culture solution with the addition of litmus, and leaves them at a temperature of 37°. If the next morning the liquid is found colourless *Spirillum choleræ* is present.

Fatty Acids in Soap.—A. Bertschinger takes 100 c.c. of a solution of 25 grms. of the soap in 500 c.c.; decomposes it on the water-bath with 25 c.c. normal sulphuric acid, washes the fatty acids upon a tared filter, dries along with the filter in a beaker, and weighs. The filtrate and washings serve for the determination of total alkali.

Quick Method for Determining Acetic Acid in Acetates.—A. Sonnenschein (*Chemiker Zeitung*) takes 5 grms. of the powdered sample of sodium acetate and dissolves them in water in a beaker with the aid of heat, and makes up in a flask to 250 c.c. If carbonaceous matter is present it is filtered off before making up; 50 c.c. of the clear liquid are mixed with three drops of phenacetoline in a porcelain capsule. If a red colour is produced it is titrated with hydrochloric acid until it turns to a yellow. The acid consumed is calculated as sodium carbonate. Two drops of methyl-orange are next added, titrating until redness appears. The acid consumed is calculated as acetic acid or sodium acetate. Acetate of lime gives a coloured solution, and must be treated with carbonic acid, boiled with animal charcoal, filtered, and made up to a known volume.

Examination of Glue. — R. Kissling (*Chemiker Zeitung*).—This paper requires the accompanying illustrations.

Examination of Commercial Quinine Sulphate.—De Vrij.—From the *Pharm. Journal and Transactions.*

The Acidity of Human Urine.—E. von Brücke (*Monathshefte fur Chemie*) denies such acidity, as it does not turn a solution of congo-red blue.

Determination of Urea. — P. Cazeneuve and Hugounenq.—From the *Bulletin de la Soc. Chemique.*

Rautenberg's Titration of Urea with Mercuric Nitrate.—This process, which is condemned by Pflüger, is defended by Pfeiffer.

Reaction of Animal Fluids.—C. Wurster mentions that in presence of ammoniacal salts congo-red reacts slowly even with mineral acids, and far more imperfectly with organic acids and carbonic acid.

Total Nitrogen in Urine.—L. Garnier.—From the *Journal de Pharmacie et Chimie.*

A New Reductive Substance in Urine.—J. Marshall.—From the *American Journal of Pharmacy.*

Alkaline Solution of Bismuth as a Reagent for Sugar in Urine.—Nylander's modification of Böttger's process is warmly commended by C. le Nobel.

The Multiplier for the Determination of Sugar in Urine.— Roberts.— A controversy for which the editor refers to *Pfluger's Archiv.*

Detection of Aniline, Acetanilide, and Paramidophenol in Urine.—F. Müller.—For the detection of aniline is mentioned the intense blue colour produced on adding dilute hydrochloric acid, kairine, and potassium nitrite.

New Substance in Urine analogous to Indoxysulphuric Acid.—J. Thormaehlen.—The author attempted to isolate this compound from the urine of horses, but did not succeed.

Detection of Small Quantities of Digestive Ferments in Animal Liquids.—For this paper we must refer to the original.

Reagent for Albumen.—G. Mya proposes potassium nitroprusside, the urine being previously acidified with acetic acid.

Detection of Arsenic.—This memoir cannot be reproduced without the accompanying figure.

The Atomic Weight of Fluorine.—O. T. Christensen.—The author finds the value 18·94 (O=15·96) or 18·99 (O=16).

Atomic Weight of Cerium.—H. Robinson.—From the Chemical News.

Part 2.

Volumetric Determination of Molybdic Acid and of Lead.—Carl Schindler.—If solutions of ammonium molybdate and of lead acetate are brought in contact there is formed a white precipitate of lead molybdate, which quickly settles if heated. Chatard has already utilised this reaction for the gravimetric determination of molybdic acid. The author applies it for a volumetric determination of both bodies, using an aqueous solution of tannin as indicator. If a drop of this solution is allowed to touch a solution of ammonium molybdate, placed upon a white porcelain plate, there appears, according to the concentration of the molybdate solution, a colouration blood-red to yellowish, distinctly visible at a dilution of 1 : 400,000, whilst the insoluble lead molybdate gives no colour, and lead acetate, if very strong, gives merely a faint greenish-yellow colour which cannot be confounded with that just mentioned. If we have a solution of ammonium molybdate and precipitate it by the successive addition of solution of lead acetate, a drop of the liquid gives the above reaction as long as molybdic acid remains in solution. Inversely a solution of lead precipitated in a corresponding manner with solution of molybdate does not give this reaction until all the lead is thrown down and molybdic acid is present in slight excess. For the titration the following solutions are required:—(1) Solution of lead acetate, prepared as follows:—40 to 50 grms. lead acetate are dissolved in water with the addition of a little acetic acid. The solution is let down to 1 litre and standardised with pure ammonium molybdate, which contains 81·55 per cent molybdic acid. (2) A solution of ammonium molybdate, of which 1 c.c. =1 c.c. of the lead solution, 20 grms. of commercial ammonium molybdate are dissolved in 700 to 800 c.c. of water. Ammonia is added until the slight turbidity disappears and the liquid is standardised to Solution 1. (3) Dilute solution of tannic acid in water; about 0·1 grm. to 30 c.c. It should be prepared fresh for every series of experiments. The analysis is executed as follows:—The molybdic solution, slightly acidified with acetic acid, is placed in a beaker and boiling water is added until the liquid reaches the volume of 300 to 400 c.c. Lead solution is then dropped in until the molybdic acid is entirely precipitated and a small excess of lead remains in solution. It is stirred and let settle for a moment. Then a large drop is taken from the upper layer of the solution by means of a fine dropping tube and brought in contact with a drop of the tannin solution upon a porcelain plate, If sufficient lead has been added there appears no colour. One-tenth c.c. of the titrated molybdic solution is now added, stirred, let settle, and tested again with the tannin solution. This is repeated until a drop produces a distinct orange colour. The volume of the molybdic solution consumed is deducted from that of the lead solution, and the molybdic acid is calculated from the remainder. In determining the lead in a liquid the procedure is analogous. The liquid containing the lead is slightly acidified with acetic acid, and molybdic solution is added until a drop of the liquid gives the molybdic reaction. If the quantity to be determined is not approximately known it should be ascertained by a preliminary experiment. A small excess of lead solution (about 0·5 c.c.) is used, titrating back with molybdic solution. The tannin drops are best placed upon a porcelain plate with depressions.

Volumetric Determination of Phosphoric Acid.—Carl Schindler.—For the execution of this process we require the following solutions:—(1) Molybdic acid. To 1 litre of molybdic solution prepared as usual there are added 30 c.c. of a solution containing 500 grms. citric acid per litre. (2) Strong solution of ammonium nitrate containing 750 grms. NH_4NO_3 per litre. (3) Dilute solution of ammonium nitrate containing 100 grms. NH_4NO_3 per litre and 10 c.c. HNO_3. (4) Magnesia mixture (Fresenius). (5) Solution of lead of which 1 c.c. represents 0·04 grm. P_2O_5. It is prepared by dissolving 55 grms. lead acetate in 1 litre water and standardising with any solution of phosphoric acid of known strength. (6) Solution of ammonium molybdate of which 1 c.c. corresponds to 1 c.c. of the lead solution. It is obtained by dissolving 25 grms. ammonium molybdate in 1 litre water and standardising with Solution 5. (7) Solution of tannin. About 0·1 grm. tannin is dissolved in 20 to 30 c.c. water. This solution is always to be prepared afresh before use. The analysis is performed as follows:—50 c.c. of the nitric solution of phosphoric acid, representing 0·5 grm. of the substance, are mixed with so much of No. 2 that the liquid, after precipitation, contains—

$$\text{Vol. of No. 2} = \frac{\text{Vol. of phosphoric acid} + \text{Vol. of No. 6}}{2}$$

So much of No. 1 is then added that 100 c.c. come to 0·1 grm. P_2O_5. The whole is then heated on the water-bath to about 58°, let settle for five to ten minutes, and the supernatant liquid is filtered off. If the filtrate is heated to a higher temperature there generally appears a further deposit of ammonium phosphomolybdate, but so minute in quantity that it may be neglected. The precipitate is washed three or four times by decantation with about 50 c.c. of dilute solution of ammonium nitrate and dissolved in a beaker with liquid ammonia at 3 per cent. The solution is then placed in a ¼-litre flask, adding the rinsings of the filter (with the same solvent), 10 to 20 c.c of the magnesia mixture are added, the flask is filled up to the mark, shaken up, and the liquid is filtered through a dry filter. Of this filtrate 50 c.c. are measured off, the liquid is made up to 300 to 400 c.c. with boiling water, and so much of the lead solution (No. 5) is then added from a burette that there may remain in solution a small excess of the lead (0·5 to 1 c.c.), titrating back with the ammonium molybdate solution.

New Method of Determining Ashes.—Ludwig Reese.—The author has constructed a small apparatus, by means of which a current of hot air is passed over the heated substance; all swelling up or frothing is either prevented or made harmless, and the incineration is quickly effected. The construction of the apparatus cannot be explained without the accompanying figure.

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THE CHEMICAL NEWS.

VOL. LVIII. No. 1498.

ON THE

DETERMINATION OF SULPHUR IN IRON AND STEEL.

By J. JAMES MORGAN.

To the best of our knowledge, and as far as our experience extends, the numerous methods employed by the chemist for the determination of sulphur in iron and steel resolve into and are founded upon two well-known principles, viz., that (A) When iron or steel containing sulphur is dissolved in hydrochloric or sulphuric acids, sulphuretted hydrogen is evolved. (B) When iron or steel containing sulphur is treated with an oxidising reagent, such as nitric acid, it is converted into sulphuric acid, which is subsequently precipitated as barium sulphate.

It will better serve our purpose—viz., that of criticising—and also simplify matters if we subdivide the methods based upon Principle A into three classes, according to the after treatment of the sulphuretted hydrogen, viz.,—A I. In which the sulphuretted hydrogen is oxidised into sulphuric acid, with subsequent precipitation as barium sulphate. A II. Where a metal is precipitated as a sulphide from the solution of its salt, preferably a copper salt, by passing the sulphuretted hydrogen evolved through, with the collection of the metallic sulphide and subsequent conversion into oxide by ignition. A III. A colorimetric method, in which the sulphuretted hydrogen is passed through the solution of a metal and the colour compared with that obtained on treating a "standard" in a similar manner.

Methods Based on Principle A.

Class A I.—Where the sulphuretted hydrogen is oxidised into sulphuric acid by means of bromine, &c., and subsequently precipitated as barium sulphate.

Class A II.—In which the sulphuretted hydrogen is conducted through a solution of copper sulphate, lead acetate, or a cadmium salt, and the resulting metallic sulphide collected, and in some instances converted into oxide by ignition.

The above two methods do not call for any special remarks. In point of accuracy there is very little to choose between them, but perhaps A I. may be said to be the better of the two. As regards the time required for their performance A II. has a decided advantage, being more expeditious.

Class A III.—As an illustration of this class we shall take Parry's colorimetric method, full details of which appeared in the CHEMICAL NEWS (vol. lvi., p. 13).

Our experience of this method is that it furnishes very good results. We may here remark that the non-uniformity in composition of the steel employed as a "standard" is felt in a more marked degree than in the colorimetric determination of combined carbon. The employment of permanent standards is recommended as a remedy, but we are adverse to the same, not deeming them satisfactory. We have therefore no other alternative than to make the best of a bad job, exercising great care in the selection of the standard, and making determinations of the sulphur in each fresh batch of drillings.

General Remarks.—All the methods founded upon Principle A possess one common and serious drawback, viz., the probability of the acid solution, as well as the insoluble residue, containing small quantities of sulphur. It therefore becomes necessary for the operator to test both these, at the expenditure of considerable time and labour, before he can vouch for the accuracy of his results.

With the exception of Parry's and Eggertz's methods the temperature employed has no effect, either injurious or otherwise, upon the accuracy of the results. With Parry's method it must not be sufficiently high to drive over acid fumes, otherwise the colour of the lead acetate solution will be destroyed (this is equally applicable to A II. when the absorbent employed is a solution of lead acetate), while with Eggertz's test a temperature above 40° C. is found to vitiate results.

As far as our experience goes the rate at which the gas is evolved does not appear to influence the results as long as it is caused to pass through a *high column* of the absorbing solution. In employing the oxidation method of Class A I. it is perhaps advisable to allow the gas to pass twice through the oxidising solution.

Principle B.

In this method the sulphur is oxidised into sulphuric acid, with subsequent precipitation as barium sulphate.

The objections brought against this method are that—(1) Nitrates are precipitated by barium chloride, and that the barium sulphate precipitate would therefore, in all probability, be contaminated with *barium nitrate.* Granted; but if this were the case it would show great carelessness on the part of the operator. This source of inaccuracy may be effectually removed by repeatedly evaporating to dryness the solution containing the sulphuric acid, after the addition of hydrochloric acid. And even supposing it comes down with the barium sulphate, digestion with ammonium acetate will remove it. (2) The results are either too low or too high, according as to whether the solution contains an excess of acid or an amount insufficient to keep the iron in solution. Both these objections are overcome by expelling the excess of acid by evaporation and diluting to a large volume previous to the precipitation of the sulphuric acid, only having sufficient acid present to turn blue litmus-paper decided red. (3) The time required for its performance is considerable. Granted; but we are of opinion that it is better to make a sacrifice of time than of accuracy. When desired the operation may be considerably shortened by neutralising the excess of acid, after the operator has satisfied himself that the whole of the nitric acid is expelled, by the addition of ammonia.

Another objection advanced by those chemists who are antagonistic to the method, is that barium sulphate is soluble (although, we may state, only *slightly* so) in acid solutions of ferric chloride. As it is essential for the satisfactory working of the method that the solution containing the sulphuric acid be decidedly acid, there is, as is obvious, always the danger of an excess being present; their objection, therefore, as far as it goes, is perfectly reasonable and valid.

We have had considerable experience with this method, employing nitric acid as an oxidant, and have always found it to furnish accurate and concordant results.

Conclusion.—We are of opinion that in the hands of an operator who rigidly observes the precautions which are so essential for the successful carrying out, not only of this but any method in which the sulphur is oxidised into sulphuric acid by means of nitric acid, as Principle B, is by far the best and most reliable of all the methods with which we have dealt. And also that all results obtained by the other methods should be checked by it before being finally accepted as correct. Furthermore we are of opinion that Parry's colorimetric method in the hands of a skilful operator yields results which will compare favourably with those obtained by any of the other methods.

The Laboratory, Ebbw Vale,
July 27, 1888.

Transferrers of Oxygen.—Lothar Meyer.—The author examines the power of salts in boiling aqueous solutions to oxidise sulphurous acid. The most powerful action is that of manganous sulphate.—*Zeitschrift.*

ON THE

INFLUENCE OF LIGHT UPON THE EXPLOSION OF NITROGEN IODIDE.

By J. W. MALLET.

The statement of L. Gattermann in his recent paper (*Berichte d. Deutsch. Chem. Gesellsch.*, xxi., 751, following up V. Meyer's paper in same vol., 26) on nitrogen chloride, that its explosive decomposition may be brought about, or its susceptibility to explosion much increased, by exposure to bright light, has recalled to my mind the fact, which did not specially impress me at the time, that I myself undoubtedly observed the same relation several years ago in the case of nitrogen iodide.

In a paper on the preparation and composition of the latter substance, published in the first number of the *American Chemical Journal* (April, 1879), it was noted that on two occasions the product obtained with the composition NI_3 or N_2I_6 "exploded in some quantity *under water* with much violence and complete shattering of the vessel."

I remember distinctly that in one of these cases I had just carried to a window, through which the sun was shining, the beaker full of water at the bottom of which was the black sediment of iodide, and was gently stirring the liquid with a glass rod, holding the beaker up so as to look at it from below, when the rod touched the lower part of the side or the bottom of the vessel, and the explosion occurred.

In the other case the iodide was being washed with ice-cold water of ammonia, the vessel standing on a table exposed at the time to the direct rays of the sun. I do not remember with certainty what seemed to precipitate the explosion on this occasion, but I believe it was the pouring some fresh liquid, from the height of a few inches, on the black sediment of iodide which had just been partially drained by decantation.

Under ordinary circumstances nitrogen iodide, while *wet*, exhibits no extraordinary sensitiveness, and may be safely worked with, only becoming highly dangerous on drying, so that I have little doubt that bright sunlight was influential in bringing about these two explosions.—*Amer. Chem. Journ.*, Vol. x., No. 4.

THE VOLTAIC BALANCE.

A New and Simple Lecture Experiment.

By Dr. G. GORE, F.R.S.

Take two small clean glass cups containing distilled water; simultaneously immerse in each a small voltaic couple, composed of either unamalgamated magnesium or zinc with platinum, taking care that the two pieces of each metal are cut from the same piece and are perfectly clean and alike. Oppose the currents of the two couples to each other through a sufficiently sensitive galvanometer, so that they balance each other and the needle does not move. Now dip the end of a slender glass rod into a very weak aqueous solution of chlorine, bromine, iodine, or hydrochloric acid, and then into the water of one of the cups. The voltaic balance is at once upset, as indicated by the movement of the needle, and may be shown to a large audience by means of the usual contrivances.

The chief circumstance to be noticed is the extremely great degree of sensitiveness of the arrangement in certain cases. This is shown by the following instances of the minimum proportions of substance required to upset the balance with an ordinary astatic galvanometer of 100 ohms resistance and with a Thomson's reflecting one of 3040 ohms resistance.

1. *Zinc and Platinum with Iodine.*—With the astatic galvanometer, between 1 in 3,100,000 and 3,520,970 parts of water.

2. *Zinc and Platinum with Hydrochloric Acid.*—With the astatic galvanometer, between 1 in 9,300,000 and 9,388,185 parts; and with the reflecting one, between 1 in 15,500,000 and 23,250,000 parts.

3. *Magnesium and Platinum with Bromine.*—With the astatic galvanometer, between 1 in 310,000,000 and 344,444,444 parts.

4. *Zinc and Platinum with Chlorine.*—With the astatic galvanometer, between 1 in 1,264,000,000 and 1,300,000,000 parts.

5. *Magnesium and Platinum with Chlorine.*—With the astatic galvanometer, between 1 in 17,000,000,000 and 17,612,000,000 parts; and with the reflecting one, between 1 in 27,062,000,000 and 32,291,000,000 parts of water.

Every different soluble substance requires a different proportion, and with unlike substances the difference of proportion is extremely great. With solutions of neutral salts the proportion of substance required to upset the balance is large; for instance, with chlorate of potash, a zinc-platinum couple, and the astatic galvanometer, it lay between 1 part in 221 and 258 parts of water.

The degree of sensitiveness of the balance is usually greater the greater the degree of chemical affinity the dissolved substance has for the positive metal and the less it has for the negative one.

By first bringing the balance with a magnesium-platinum couple and the astatic galvanometer nearly to the upsetting-point, by adding 1 part of chlorine to 17,612 million parts of water, and then increasing the proportion to 1 in 17,000 millions, the influence of the difference, or of 1 part in 500,000 millions, was distinctly detected.

THE MANUFACTURE OF ALUMINIUM: CASTNER'S PROCESS.

For many years the production of aluminium at a low price has hovered before the eyes of metallurgists, but has still eluded their grasp. Steps have indeed been taken by which this metal has been obtained of higher purity and at a reduced cost. We need only refer to the Webster process, now being worked, as we understand, at Solihull, near Birmingham; the electric method devised by the Messrs. Cowles, and which is in actual use on a large scale; and the electric process of Dr. Kleiner, of Zurich, who decomposes the double aluminium and sodium fluoride (cryolite) by an electric current. Still, however, the cost price of the metal has been so high as to prevent not a few of the applications for which it is otherwise well adapted. It is therefore satisfactory to find that a process is being actually introduced at Birmingham by the Aluminium Company, Limited, which—if we make every possible allowance for the eagerness of inventors—will at last put us in possession of cheaper aluminium. The inventor of this new process is Mr. H. Y. Castner, of New York, who has been experimenting upon this important subject for some years. Two years ago he established trial works at Lambeth, and, after further experimentation, he convinced the most experienced metallurgists that he could produce sodium at about one-fifth and aluminium at one-third of their respective former costs. Upon the faith of these results the Aluminium Company was formed, and works were erected at Oldbury, near Birmingham, which came into successful operation about a fortnight ago. On Saturday, July 28th, the process was shown in full operation to a number of scientific and practical gentlemen.

The manufacture resolves itself into four stages:—(1) the production of sodium under the Castner patents; (2) the production of the necessary supply of chlorine by the Weldon process; (3) the manufacture of the double aluminium and sodium chloride by a new process,

invented and patented by Mr. Castner; and (4) the reduction of this double chloride by means of sodium. The first capital improvement is in the production of sodium from caustic soda. The reduction is effected by means of iron carbide in steel retorts, and at the relatively low temperature of 800°, instead of 1500° as in the old process: 1 lb. of sodium is obtained from 6 lbs. caustic soda and 5 lbs. of the iron carbide. The saving in fuel, in wear and tear, and in time is such that, whilst sodium formerly cost 6s. per lb., it is now produced at about 9d. There is no need for us to enlarge on the benefits of cheap sodium, irrespective of the manufacture of aluminium.

As regards the generation of chlorine a very interesting fact is that Messrs. Chance Bros., of Birmingham, the enterprising alkali manufacturers, supply the Aluminium Company with the necessary muriatic acid, and receive in return the crude carbonate of soda, a residue from the production of sodium.

The double aluminium and sodium chloride is formed by passing chlorine gas over a mixture of alumina, salt, and carbon placed in large retorts of a peculiar construction and heated to a high temperature. The chloride formed distils over, and is caught in special condensers. The plant admits of the daily production of 6000 lbs. double chloride, containing about 12 per cent of aluminium, and yielding in practice 10 per cent. Here, again, a considerable economy is effected.

The last stage, the extraction of the aluminium, is effected in furnaces, each of which receives a charge of 80 lbs. of the double chloride, 25 lbs. of sodium, and 30 lbs. of cryolite, which acts as a flux. The charge is heated for two hours to about 1000°, and yields about 8 lbs. of aluminium, the impurities in which do not exceed 2 per cent.

The daily output of sodium is expected to reach 1500 lbs., that of aluminium being 500 lbs. The entire daily production in the world has hitherto been estimated at about 50 lbs.

Before referring to the many possible purposes to which aluminium may be applied, we may venture to glance at an invention by which it is said that this metal may be produced at the cost of a few shillings per pound without the employment either of sodium or an electric current. The uses of aluminium turn on its lower specific gravity, 2·67 (one-fourth that of silver or one-third that of iron); its enormous tensile strength, whether in the pure state or in various alloys; its resistance to the oxidising action of the air, even at comparatively high temperatures, and to the attacks of sulphuretted hydrogen; the beauty of its alloys; and lastly, its sonorous character. Hence, as soon as obtained at a suitable price, it will be the established material for bells, where its lightness will be an additional recommendation for what—on account of their material—are now called "brass" instruments of music, and for pianoforte strings.

Turning to another field, all those parts of balances, telescopes, microscopes, spectroscopes, and other scientific instruments now made of brass, will doubtless be constructed of aluminium.

The question of price has been hitherto the only objection to its use for telegraph-wires. This will be especially the case in the field-telegraphs now employed in military operations. It is evident that a soldier, in laying down such a line, can carry aluminium-wire enough for 3 miles as easily as iron-wire enough for 1 mile, and, in addition, the supports can be lighter and less cumbersome.

Aluminium will also supply "plate" equal in appearance to silver, and not liable to tarnish. An alloy of 1 part of aluminium with about 9 parts of copper rivals gold both in beauty and permanence, and has already come into some use for watch-cases, chains, pencil-cases, and other ornamental articles.

Perhaps in these days of rivalry in the production of warlike appliances one of the greatest outlets for cheap aluminium will be in the manufacture of aluminium bronzes. Official experiments, here and elsewhere, have shown that castings of these materials possess a tensile strength far in excess of forged iron or steel when made into heavy guns. Such guns henceforth may be cast in any ordinary foundry and finished in the lathe, dispensing with the forging, welding, and shrinking on of rings, the tempering, drilling, and annealing now necessary in the production of the largest guns. Time will be saved, and the service will be supplied with guns at once lighter and more powerful. Mr. Nordenfeldt has discovered, some time back, that castings equal in strength to wrought-iron can be obtained if a little aluminium is incorporated with the fused metal.

All these applications, and others which will readily suggest themselves, only require cheap aluminium to pass at once from the experimental to the practical, industrial stage.

The cost of aluminium is at present from 40s. to 45s. per pound. The Castner process brings the price down to about 15s. This figure may still seem high for many uses; but we must remember that, in consequence of the low specific gravity of aluminium, a given weight of the metal will do the duty of a threefold heavier weight of the ordinary industrial metals. That improvements will be made, further reducing the cost of production, can scarcely be doubted.

DETERMINATION OF SULPHUR IN COKE.

By L. BLUM.

The author examines the reasons given by different chemists, such as W. Crossley, Crace Calvert, and W. A. Bradbury, to account for the fact that the percentage of sulphur is always found lower by the wet processes than by fusion with alkaline salts. He then analysed ten samples of coke by the potassium chlorate and the bromine and hydrochloric acid method, and obtained results in no case reaching 0·3 per cent. With aqua-regia a percentage of 0·316 was obtained, but the residues on fusion yielded further 0·723 and 0·798 of sulphur. The same samples were then treated by fusion with a mixture of 16 parts sodium chloride, 8 parts potassium nitrate, and 4 parts sodium carbonate, all perfectly dry.

One grm. of the sample was placed in a capacious platinum crucible along with 28 grms. of the saline mixture, thoroughly incorporated, and then ignited. As long as the development of gas in the melt was copious the crucible was heated only to low redness (at the front of the muffle). When the chief action was over a stronger heat was applied until the melt was in a tranquil flux. The melt when cold separates readily from the crucible. It is dissolved in water acidulated with hydrochloric acid. After a further addition of strong hydrochloric acid (in order to decompose any existing nitro-compounds) it is evaporated to dryness, taken up again in hydrochloric acid and water, the silica which separates is filtered off, and the sulphuric acid is determined gravimetrically in the filtrate by means of barium chloride. All the samples treated in this manner gave percentages of sulphur ranging from 0·907 to 1·147.

These results prove the utter uselessness of all the wet methods.

The author agrees with F. Muck that, in addition to the sulphur present as calcium and iron sulphide, there is a compound present derived from the organic sulphur of the coal. The sulphur of the sulphides is dissolved by acids and oxidising agents, but the organic sulphur resists such agents.

Herr Blum suggests that in future it may be required to determine separately the proportion of sulphur existing in each of these two states. This may be effected by first determining total sulphur as above, and then estimating the portion combined with Ca or Fe by means o

the potassium chlorate, the bromine and hydrochloric acid, or the aqua-regia method.—(Separate Reprint from the *Zeitschrift für Analytische Chemie.*)

THE CLASSIFICATION AND NOMENCLATURE OF METALLINE MINERALS.*

By T. STERRY HUNT.

1. The writer in April, 1885, presented to the National Academy of Sciences the project of A Natural System in Mineralogy, which was farther elaborated in an essay before the Royal Society of Canada in May of the same year, published in Volume III. of the *Transactions* of that Society, and with revisions and additions in his "Mineral Physiology and Physiography" in 1886 (pp. 279—401). In† this essay it was maintained that such a system cannot be established on the sensible characters of the species alone, as taught by the school of Mohs, nor yet on chemical composition and relations to the neglect of such characters, in accordance with the views of the Berzelian school or of those who propose a chemico-crystallographic scheme like that of Groth. It was the aim of the writer to show that the hardness, the specific gravity, and, moreover, the greater or less susceptibility to chemical change in species are intimately related to chemical constitution; and that a natural system of classification which, in the words of John Ray, "neither brings together dissimilar things nor separates those which are nearly allied," must take into account all these various characters and relations, alike dynamical and chemical. The error of attaching an undue importance to a single subordinate character is illustrated in the case of crystalline form, which may vary, while specific gravity, hardness, colour, lustre, and chemical composition all alike remain unchanged, as seen, for example, in the native sulphides of zinc and of silver.

In pursuance of these ideas the whole inorganic kingdom was declared to belong to Mineralogy, although as a branch of Natural History it is generally confined to native species. The real position of mineralogy, as distinguished under its various heads of Systematic, Descriptive, and Physiological Mineralogy, is set forth in the following tabular view of the natural sciences, copied with slight revision from the volume just cited.

2. The classification then proposed by the writer divides the mineral kingdom into four classes, namely: I., *Metalline;* II., *Oxidised;* III., *Haloid;* and IV., *Pyricaustate* (combustible or fire-making) species. These again are divided into orders, and in some cases into sub-orders, as was set forth on page 382 of the already cited volume. In the large and important order of the Silicates, the only one then considered in detail, there was recognised in each one of its three sub orders of Proto-silicates, Proto-persilicates, and Persilicates—five tribes, designated Hydrospathoid, Spathoid, Adamantoid, Phylloid, and Colloid (or Porodic); called in some cases by other more distinctive synonyms as Pectolitoid, Zeolitoid, Ophitoid, and Argilloid; in farther extension of which, we may say, Amphiboloid, Feldspathoid, Granatoid, Topazoid, Talcoid, Micoid, &c., for the other tribes. The characteristic species of these tribes were then critically examined as regards chemical composition and the relations of this to specific gravity and to hardness. These relations were shown in separate tables for the various tribes, and farther in three synoptical tables of the sub-order (*loc. cit.*, pp. 399—401). The order of the Oxydates (included, like the last, in the class of the OXYDACEÆ) was at the same time more briefly considered, and shown to include representatives of five similar tribes (p. 376). In various orders of the same class, such as Carbonates and Borates, as likewise in the sub-orders of the HALOIDACEÆ, such as Chlorides, the soluble and sapid species were recognised as forming tribes—Carbo-salinoid, Boro-salinoid, and Chloro-salinoid—contrary to the teaching of Mohs and his followers, who made these characters the basis of a class-distinction. It should be added that the species of all these various tribes have farther to be arranged in genera, and to complete the system require a binomial Latin nomenclature.

3. In the study of the various species of the order of Silicates, notice was in every case taken not only of the specific gravity of the species, but of the relations between this and its equivalent or so-called molecular weight, as shown in what is generally known as its atomic volume, calculated by the formula $p \div d = v$. For the purpose of thus comparing related species it was necessary to fix a simple unit for p. As we have since said in the study of the species of Classes II and III.: "We assume as the unit for p a weight including that of $H = 1{\cdot}0$, of $Cl = 35{\cdot}5$, or of $O \div 2 = 8{\cdot}0$. By thus adopting a combining weight of 8·0 for oxygen as a basis, we get a unit which gives a common term of comparison for oxides, sulphides, chlorides, fluorides, and for intermediate compounds like the oxysulphides and oxyfluorides common in native species. It is, of course, a hypothetical unit which, for elemental species and for fluorides, chlorides, &c., corresponds with the normal vapourous species; but for oxidised species is some fraction thereof, as in the cases of water-vapour, H_2O, of spinels, and other oxides.

* Read before the American Philosophical Society, May 4, 1888.
† See also supplement to "A Natural System of Mineralogy," *Trans. Roy. Soc. Can.* for 1886, Vol. iv., Part 3.

			INORGANIC NATURE.	ORGANIC NATURE.
NATURAL SCIENCES.	Descriptive.	*General Physiography or Natural History.*	Mineral Physiography.	Biophysiography.
			Astronomy, descriptive.	Organography.
			Mineralogy,	Botany and Zoology,
			descriptive and systematic.	descriptive and
			Geognosy. Geography.	systematic.
	Rational.	*General Physiology or Natural Philosophy.*	Mineral Physiology.	Biophysiology.
			Dynamics. Chemistry.	*Biotics.*
			Astronomy, theoretical.	Organogenesis. Morphology.
			Mineralogy, physiological.	Botany and Zoology,
			Geogenesis.	physiological.

"We may readily extend this system of hypothetical units from silicates to carbonates, sulphates, phosphates, and more complex species by dividing in all cases the empirical equivalent weight by twice the number of oxygen portions (O = 16·0), plus the number of chlorine or fluorine portions. We have for example :—

		p.
Forsterite	$SiMg_2O_4 = 140 \div 8$	17·50
Calcite	$CCaO_3 = 100 \div 6$	16·66
Karstenite	$SCaO_4 = 136 \div 8$	17·00
Gypsum	$SCaO_4 \cdot 2(H_2O) = 172 \div 12$ ..	14·33
Apatite	$3(P_2Ca_3O_8) \cdot CaF_2 = 908 \div 50$	18·16

"In the writer's late essay on "A Natural System in Mineralogy," the values of *p* have been thus determined. These silicates are there represented by a new notation which employs symbols in small letters to represent quantivalent ratios; the combining weights of the elements being divided by their valency, and in all cases followed by their coefficients. The formula of forsterite thus becomes $(mg_1si_1)o_2$, that of orthoclase, $(k_1al_3si_{12})o_{16}$, and that of topaz, $(al_3si_2)o_4f_1$.

"While a similar unit is equally applicable to all haloid species, it has been found more convenient for the metalline species which constitute Class I., including unoxidised metals and their compounds with one another, and with arsenic, antimony, sulphur, selenium, and tellurium, to divide the formula by the sum of the valencies therein represented; so that for all such species the unit *p* gives not the mean integral weight of an oxygen compound in which O = 8, but that of the element corresponding to S = 16, to Fe = 28, to Ag = 108, to As = 25, Sb = 40, and Bi = 69·3,"* represented respectively by s_1, fe_1, ag_1, as_1, sb_1, and bi_1.

4. The law of condensation and of expansion by volumes, familiarly known in the chemistry of gases and vapours at ordinary pressures, is, as the writer has endeavoured to show, still further exemplified in the case of the very dense vapours into which, under much greater pressures, liquids like water, alcohol, hydrocarbons, and, theoretically, all chemically stable liquids, pass when heated sufficiently; that is to say above their so-called critical points, when they necessarily assume the vapourous condition. The conversion of all gases and vapours by reduction of temperature and augmentation of pressure into liquid and solid forms, helps us to understand that the same laws of combination by weight, and of condensation or integration of volume, apply alike to gases and vapours on the one hand, and to liquids and solids on the other. The relation of condensation (represented by specific gravity) to equivalent weight, which thus becomes a fact of fundamental importance, is shown by comparing the quotient got by dividing the received equivalent (so-called atomic or molecular) weight by the specific gravity of the body as determined for all liquid and solid species, taking water as unity, as in the formula $p \div d = v$. The equivalent weight *p* is, as we have seen, that deduced from the empirical chemical formula calculated from hydrogen as unity.

Thus hydrogen being 1 = H, the equivalent weight of carbon dinoxide, whether as gas, liquid or solid, is assumed as $44 = CO_2$; that of water, in any of its states, is taken as 18 (or, more exactly, 17·96) $= H_2O$, and that of the various forms of silica as $60 = SiO_2$; while that of carbonate of lime, whether as calcite or aragonite, is $100 = CCaO_3$. These weights in the case of gaseous bodies are really the weights of equal volumes, compared with that of hydrogen at the same temperature and pressure, and are truly equivalent weights. The law of condensation, however, shows us that, in the case of liquid and solid species, we have to deal with much more complex formulæ than these. In fact, the minimum equivalent weights deduced from analyses of the chlorides of the ammonio-cobalt bases give numbers of 500 and upwards, and, in the case of a certain metaphosphate, equal 2540. The complex potassio-cobaltic nitrite is represented by a formula giving an equivalent weight of not less than 958. These weights are surpassed by those deduced for the complex silico-tungstates and phospho-tungstates, our knowledge of which has been much extended by the late researches of Wolcott Gibbs on what he has called "the complex inorganic acids." Therein he has made known the existence of progressive or homologous series, the successive terms of which differ by $2WO_3$, and rise from $4WO_3$ to $24WO_3$, and even $60WO_3$; having formulæ from which the minimum molecular weights deduced are represented by many thousands, H = 1. Thus the golden insoluble crystalline compound of tungsten, oxygen, and sodium, described by Wöhler, is probably, according to Gibbs, $16WO_3 \cdot 4WO_2 \cdot 7Na_2O = 5{,}002$, while to another crystalline species, soluble in water and hydrous, he ascribes the formula,—

$$60WO_3.3P_2O_5.2V_2O_5.VO_2.18BaO + 144H_2O = 20{,}058.$$

This, according to him, has "the highest molecular weight yet observed." The studies of Gibbs and of many others whose work in this field has been briefly summarised by the writer ("Mineral Physiology," pp. 386—389), unite in showing that a great complexity of composition may exist in definite crystalline compounds, and moreover, that very small portions of different substances may not only occur as necessary elements in such a compound, but may even change essentially its chemical relations. Thus, in a complex tungstate containing $12WO_3 = 2784$, the addition of $SiO_2 = 60$ suffices to determine the production of a new type with changed basicity. In like manner the addition to a compound, containing $24WO_3 = 5568$, of $P_2O_5 = 142$, gives a new and distinct acid type. Moreover, oxygen in these bodies may be in part replaced by fluorine; while platinum, selenium, tellurium, and many other elements may enter in small but definite amounts into the polytungstates and polymolybdates, as well as organic radicles, such as methyl, ethyl, and phenyl. These remarkable results are regarded by Gibbs as forming "a new department of inorganic chemistry." In commenting upon them, however, it has been elsewhere said:—

"It will be remembered that I had already, in 1853, proclaimed that the whole chemistry of solids and liquids is only intelligible when regarded as a history of just such complex inorganic acids and salts; that the distinction between organic and inorganic chemistry is no longer tenable; that the same principles of homology and polymerism are applicable alike to the bodies of the carbon series and the silicon series; that the native crystalline carbonates, or carbon-spars, are polycarbonates, with equivalent weights of not less than from 1500 to 2500; that the pyroxenes, felspars, and tourmalines are polysilicates of equally complex constitution, and are represented by formulæ which show the existence among them both of polymers, probably homologous, and of anisomeric homologues. These conceptions, all of which were explicitly set forth and defended in 1852 and 1853, underlie the writer's philosophy of the mineral kingdom, as then enunciated, and as persistently maintained to the present date."*

5. It was not, however, till a much later date that a farther attempt was made to fix the *integral weight*, as I have designated the so-called molecular weight of solid species. By extending to such species the law of equivalent volumes, the conclusion was reached that their integral weights were even far greater than had been suspected by the writer in 1853. In fact, that of water itself, the unit of specific gravity for liquids and solids, being, in round numbers, 21,400,† the weights for these

* "A New Basis for Chemistry," 2nd Edition, § 139; also the author on "Chemical Integration," *American Journal o Science*, August, 1887.

* "A New Basis for Chemistry," 1887, § 27.

† In liquid water 1192 volumes of water-vapour at standard temperature and pressure are condensed into a single volume, which, if $H_2O = 17{\cdot}96$, gives an integral weight of 21,408; but in view of the

various species must be as much greater as their specific gravities are higher than this unit. We thus find that the solid forms of carbon dinoxide and silicon dinoxide, of carbonate of lime, and even of the ammonia-cobalt salts, and the highest members of the polytungstate series, represent in all cases polymeric or condensed derivatives of the normal species, which is, for the most part, unknown, or appears, as in the case of CO_2 and H_2O, in a gaseous form. A species like calcite, of sp. gr. 2·729, is represented by $584CCaO_3$ or by $C_{584}Ca_{584}O_{1752}=58,400$. In like manner other mineral species must be represented by formulæ more complex and weights far higher than those deduced by Gibbs for his polytungstates. In the case of such compounds, partial substitutions, and small additions, affecting but slightly the centesimal composition of a species, may nevertheless be essential to its chemical constitution, as shown by Gibbs in the cases of silicic and phosphoric oxides added to the polytungstates. In the formula above assigned to calcite, with Ca_{584}, the substitution of Mg_{10} would introduce into the species only 0·72 of magnesia. Such substitutions and small additions would, however, if found in ordinary analyses of mineral species, be disregarded as impurities not essential to the composition. In like manner the small amounts of fluorine, of chlorine, of hydrogen, of boron, and of phosphorus, so often met with in native silicates, are not to be looked on as accidental ingredients, but as essential parts of highly complex integers. Farther and more critical chemical analyses are necessary before we can fully know the constitution of dense insoluble species, and the great difficulty is to decide how far these small portions of elements are due to impurities, and how far they are elements necessary to the constitution of the species, questions which in many cases can only be solved by much care and study.

6. The non-oxidised metalline minerals, embracing the metals, their alloys, and all their compounds with sulphur, selenium, tellurium, phosphorus, arsenic, antimony, and bismuth, are, in the natural-historical classification of Mohs and his followers, comprised in four orders:—Pyrites, Metals, Glances, and Blendes (Pyrites, Metalli, Lamprites, and Minia of Breithaupt). All of these we have included in Class I., METALLACEÆ, embracing but a single order, METALLATA, which is, however, divided into two sub-orders. The reasons for including the metals and their various alloys in the same order with sulphides, selenides, tellurides, phosphides, arsenides, antimonides, bismuthides, sulpharsenides, sulphantimonides, &c., are two-fold; first, the resemblances between the typical and malleable metals, such as gold, silver, lead, copper, nickel, and iron, and the elementary metalline species, tellurium, arsenic, antimony, and bismuth, are such that the compounds of these with the metals above named cannot well be separated from alloys. Another reason is to be found in the complex nature of many artificial products known to us as metals. Thus, the cast-irons from the blast-furnace are compounds, apparently homogeneous, of iron with small quantities of sulphur or of phosphorus with silicon and with carbon, while copper may, in like manner, contain small quantities of phosphorus, of arsenic, or of silicon. These constitute sulphides, phosphides, arsenides, silicides, and carbides of iron and of copper, in which the amounts of the added elements, though proportionally small, nevertheless modify profoundly the character of the compounds, affording additional illustrations of the principle insisted upon above in speaking of oxidised species.

7. The division of the Metallata into two sub-orders, which we have designated Metallometallinea and Spatometallinea, is based upon the radical differences which distinguish the great groups of the Glances and the Blendes. The first suborder, like the Glances, includes alike simple sulphides like galena, argentite, chalcocite, metacinnabar, stibnite, and molybdenite; selenides like eucairite and clausthalite; tellurides like altaite, sylvanite, and tetradymite; sulpharsenides like enargite; sulphantimonides like bournonite and stephanites; ulphobismuthides like emplectite and kobellite. To the Metallometallineæ also belongs the order Pyrites of Mohs. This not only includes the harder simple sulphides, as marcasite, pyrite, siegenite, and laurite, and as pyrrhotite, chalcopyrite, and millerite; but arsenides such as smaltite, leucopyrite, and niccolite; antimonides like breithauptite, horsfordite, and dyscrasite; sulpharsenides like arsenopyrite and cobaltite; sulphantimonides like ullmannite; and sulphobismuthides like grunauite. In this same sub-order, for reasons already given, belong the metals and alloys, including metallic arsenic, antimony, and bismuth, and also the metallic forms of selenium and of phosphorus.

In the second sub-order the metals are not represented by any known species, but by the non-metallic forms of selenium and phosphorus, and by the various modifications of sulphur. This sub-order includes, moreover, simple sulphides like sphalerite, wurtzite, greenockite, hauerite, oldhamite, cinnabar, and realgar; sulpharsenides like proustite and tennantite; and sulphantimonides like pyrargyrite and miargyrite. The opacity and lustre of the compound species of the first sub-order, and their occasionally sectile character, connect them closely with the typical metals. On the other hand, the transparency, the absence of metallic lustre and aspect from the species of the second sub-order recall the physical characters of oxides like zincite, cuprite, and senarmontite, with which they are connected through the oxysulphides, voltzite and kermesite. It is to recall these resemblances to the sparry Oxidates that we have called this sub-order Spatometallinea. It is worthy of note that not only the elements selenium and phosphorus, but the sulphides of mercury and of antimony, are found in two distinct specific forms, and belong to both of these sub-orders; and there seems some reason to believe that under the head of fahlerz, or gray copper, may be included, besides the species belonging to the Spatometallineæ, others which pertain to the Metallometallineæ.

7. In proceeding to divide into tribes and genera the various groups of species indicated in the preceding review of the order of Metallata, we are guided alike by the composition, as shown by chemical analysis, and by the physical characters of hardness and condensation. The latter, as indicated by the value of v, calculated for the elemental unit as already defined (§ 3), is the reciprocal of the coefficient of condensation. This value will be seen to diminish with the increase of hardness of the species, as represented by degrees given on the scale of Mohs, in which the hardness $=H=1·0 \ldots 10·0$.

(To be continued).

uncertainty still prevailing as to the precise weight of oxygen, hydrogen being unity, the number 21,400 is adopted as a close approximation. In former publications by the writer, by an error in calculation, instead of $1192H_2O$ the formula of water has been given as $1628H_2O$, which, with $H_2O=17·9633$, gave an integral weight of 29·244. This mistake was corrected in a note on "The Integral Weight of Water," in the *L. E. and D. Philos. Magazine* for April, and in the *American Journal of Science* for May, 1888. See also the author's "New Basis for Chemistry," 2nd Edition, *passim*.

A DETERMINATION OF THE RELATION OF THE ATOMIC WEIGHTS OF COPPER AND SILVER.*

By THEODORE WILLIAM RICHARDS.

In the Report of the Committee on Electrolysis made to the British Association at Birmingham, of which an advance copy has been received by Professor Cooke through the kindness of Dr. Oliver Lodge, a direct determination is given of the ratio between the atomic weight of copper

* Contributions from the Chemical Laboratory of Harvard College. From the *Proceedings of the American Academy of Arts and Sciences*, vol. xxiii

and that of silver, based on the electrolytic experiments of W. N. Shaw. As the value of the ratio thus obtained is quite different from that usually accepted, it seemed to Professor Cooke desirable that the results should be confirmed by a direct chemical method, and the writer was intrusted with this investigation.

Of the work worthy of consideration which has thus far been done upon the atomic weight of copper, first in chronological order comes that of Berzelius,* who made two determinations of the weight of copper formed by the reduction of pure cupric oxide by hydrogen. He found the percentage of copper in this compound to be 79·823 ± 0·002. This corresponds to an atomic weight of 63·153, taking oxygen = 15·963, with Clarke. The next determination was by Erdmann and Marchand,† who used the same method. They found the percentage of copper in cupric oxide to be 79 8645 ± 0·0038 as a mean of four determinations,—a value which makes Cu = 63·316. Millon and Commaille,‡ in three determinations,—which did not, however, closely agree with one another,—found the relation, CuO : Cu = 100 : 79·7787; and calculating from this relation the atomic weight of copper, the value 62·979 is obtained. Dumas§ made several determinations of the reduction of cupric oxide and the synthesis of cuprous sulphide, and calculates the value Cu = 63·5.

Hampe,‖ whose work gave the most concordant results thus far secured, obtained from three determinations of the percentage of copper in cupric oxide the mean value of 79·8347 ± 0·0013, and from two analyses of anhydrous cupric sulphate by electrolytic precipitation he found the proportion $CuSO_4$: Cu = 100 : 39·725 ± 0·0007. The atomic weights of copper from these two methods are respectively 63·197 and 63·173.

This was in 1874; and the subject has rested undisturbed until last year, when W. N. Shaw, in the paper before referred to, sought to prove the accuracy of Faraday's law of electrolysis in atomic proportions, by means of the actual weights of silver and copper deposited in cells in the same circuit. For the particulars of his method the Report of the Committee on Electrolysis should be consulted; it is sufficient here to say that as the mean of many determinations he finds the ratio of the silver and copper precipitated to be 3·39983 : 1. Correcting this result for variations in current density, he obtains the value 3·39888, and finally adopts the practically identical value 3·400, which makes the ratio Ag : Cu = 17 : 10. This last value makes Cu = 63·333, while the corrected value gives as the atomic weight the quantity 63·360.

Below is a summary of all the results:—

Berzelius, from CuO	63·153
Erdmann and Marchand, from CuO ..	63·316
Millon and Commaille, from CuO.. ..	62·979
Dumas, from CuO and Cu_2S	63·5
Hampe, from CuO	63·197
,, from $CuSO_4$	63·173
W. N. Shaw, by relation to silver.. ..	63·333
,, ,, ,, corrected ..	63·360

The most obvious chemical method for the determination of the relation of the atomic weights of silver and copper is by the precipitation of silver from a solution of a pure silver salt by means of pure copper; and this was the method adopted in the present determination. Hampe, in his work on the atomic weight of copper, attempted the same method, but rejected it for two reasons, —the first being that the silver dissolved, or appeared to dissolve, to a slight extent in the hot water used for washing; and the second being that it was impossible to prevent copper from coming down with the silver, no matter how long the precipitate was digested with the argentic nitrate solution. As will be seen, however, both of these difficulties have been entirely overcome.

The silver salt selected for the precipitation was the nitrate, on account of its ready crystallisation, its easy solubility in water, and the facility with which it can be obtained pure. For the preparation of the salt used in the work, ordinary pure argentic nitrate was crystallised many times from hot water, and finally fused for two hours in an air-bath kept at 205° C.—a few degrees above its melting-point. This preparation was a white translucent substance interspersed with transparent crystals, dissolving completely in water, and giving a colourless solution which was wholly neutral.

The copper used was prepared by electrolysis from cupric sulphate, through the kindness of Mr. Wilson, of the University Press. It was cut into small pieces, and these were digested in succession with weak potassic hydrate, dilute sulphuric acid, and then a very large amount of water. The copper was then boiled with water for about half an hour and washed with a large amount of distilled water, then dried and reduced at a low red heat by means of perfectly pure hydrogen, and allowed to cool in a stream of the gas. The metal thus prepared had a beautiful red metallic lustre, and showed no trace of oxidation after keeping a month. Before use it was dried in an air-bath at 110°, allowed to cool in a desiccator, and weighed by itself on a balance which was distinctly sensible to a twentieth of a milligramme. In addition to receiving the treatment described above, the copper used in the fifth and sixth experiments was oxidised in a stream of pure air for half an hour, and then again reduced by hydrogen; but the concordance of those two results with the others shows that this precaution was not necessary.

In a few preliminary experiments it was found that on the temperature of the solution, and on the temperature alone, depended the regularity with which the silver was precipitated by the copper. At 90° the deposition is very rapid, nitrous fumes are evolved, and a large amount of copper comes down with the silver. As the temperature of the solutions used is lower, the reaction becomes less rapid, and the amount of copper deposited with the silver less, until at ordinary temperatures it is comparatively small; and below 0° the silver comes down absolutely pure, and not the least evolution of gas is observed. One of the difficulties of Hampe can then be overcome by keeping the beaker containing the solution in a freezing mixture; and the perfect definiteness of the reaction, which before might have been questioned, is thus established. The duration of the reaction at −1° is from twelve to twenty-four hours, according to the dilution of the argentic nitrate. The more dilute the solution is, the longer the precipitation takes, and the more finely divided is the deposited silver; but when the solution is very concentrated the reaction is completed in a comparatively short time, and the silver comes down in a beautiful compact crystalline crust, which takes the form of the copper.

The silver which was formed was collected in a Gooch crucible and washed with cold water, of which less than 250 c.c. were necessary to give a filtrate in which no trace of silver or copper could be detected.

The fact that the determinations given below agree so exactly with each other is of itself proof that no silver was dissolved,—first, because the precipitate in the different experiments was of very different degrees of fineness; and secondly, because the precipitate in each experiment was washed with a different amount of water, the silver of the last experiment having at least four times as much water passed over it as that of the first. And the fact that the results are not affected by either circumstance shows clearly that no perceptible amount of silver could have been dissolved; for if so, the loss must have varied both with the condition of the precipitate and with the amount of the wash-water. The different result obtained by Hampe was probably the effect of hot water on a very finely divided precipitate.

* *Poggend. Annalen*, viii., 177.
† *Journ. f. Prakt. Chem.*, xxxi., 389, 1844.
‡ *Fresenius's Zeitschrift*, ii., 475, 1863.
§ *Ann. d. Chim. et Phys.* (3), lv., 129.
‖ *Fresenius's Zeitschrift*, xiii., 352, 1874.

Relation of Silver to Copper.

No. of Expt.	C.c. H_2O used.	Weight Cu taken.	Weight Ag formed.	Equivalent. $Ag_2 : Cu = 1 : n$.	Atomic weight Cu. Ag = 108.	Ag = 107·675.
1.	20	0·53875	1·8292	0·29452	63·618	63·427
2.	25	0·56190	1·9076	0·29456	63·624	63·432
3.	120	1·00220	3·4016	0·29462	63·639	63·447
4.	30	1·30135	4·4173	0·29462	63·638	63·447
5.	20	0·99870	3·39035	0·29457	63·628	63·437
6.	25	1·02050	3·4646	0·29456	63·623	63·434
			Average	0·29457	63·628	63·437

The silver, whether in crystalline plates or in crystalline powder, formed a very convenient precipitate with which to work; it was easily transferred and easily washed, did not adhere to the glass, and was in every way adapted for quantitative work.

The conditions of the following experiments as regards the quantity of water and the excess of argentic nitrate used above the amount required to dissolve the copper, were varied as much as possible. In some determinations barely enough of the argentic nitrate was used to effect the solution, while in others the excess of the silver salt amounted to nearly 2 grms. The time allowed the reactions was also varied from twenty-four to seventy-two hours.

The mean value, 63·437, has a greatest variation of ± 0·01, and a probable error of ± 0·0023.

The value obtained by Shaw was .. .. 63·333
" " " corrected.. 63·360
The value given by Clarke is.. .. .. 63·173

It remains only to prove the absolute purity of the copper used and the silver formed. The only metals which could affect the atomic weight of copper to an appreciable extent, if present in traces, are bismuth and silver. The former was tested for with great care, using a delicate spectroscope, and not the faintest trace of the very well-defined blue bismuth line was apparent; further, ten grms. of the copper were dissolved in nitric acid, a little potassic hydrate added to the diluted solution, and the whole boiled and shaken for three hours. According to Hampe, all the bismuth present will be found in the basic precipitate; this was tested qualitatively for the metal, and not a trace was found. The solution of a portion of the copper in pure nitric acid gave not the faintest trace of opalescence with hydrobromic acid, excess of ammonic hydrate, or baric chloride. A grm. of the copper was tested for arsenic and antimony in a Marsh-Berzelius apparatus, and no trace of a mirror was obtained. As the presence of so much copper would cause the generator to run too rapidly, the solution was treated with just enough potassic ferrocyanide to effect precipitation, and the colourless filtrate was run into the apparatus. This method has been found to give good results. The copper and the precipitated silver each dissolves in nitric acid without leaving a trace of residue.

If the copper is pure, the only possible impurity which the silver could contain is copper, and this was tested for with great care in each precipitate by dissolving one to two grms. in nitric acid and adding excess of ammonic hydrate. In no case was the slightest blue colour noticed, and as under the same circumstances the tenth of a milligrm. of copper gave a distinct bluish tinge it may be assumed that the silver contained no copper. This method is a convenient one for the preparation of chemically pure silver, and avoids the necessity of fusion and the concomitant absorption of oxygen and possible admixture of silicic anhydride.

Although the value of the atomic weight of copper obtained, 63·44, does not exactly coincide with Shaw's results, it is at least very much nearer to them than is the old accepted value of 63·17; especially if we take his result as corrected for current density. The new value is very nearly that found by Dumas from cuprous sulphide, and it falls within the limits assigned by L. Meyer and Seubert as the possible error of the accepted value.

OBITUARY.

JULES HENRI DEBRAY.

We much regret having to put on record the unexpected death of the distinguished chemist Jules Henri Debray, which took place on July 19th. The deceased was the pupil, assistant, and intimate friend of the late illustrious Sainte-Claire Deville, and became his successor, both officially and in the development of his ideas on dissociation. The activity of the late *savant* was incessant and manifold. He was a Member of the Academy of Sciences, Professor at the Paris Faculty of Sciences, "Mâitre de Conferences" at the Higher Normal School, Assayer to the "Garantie" of Paris, Vice-President of the Society of Encouragement for National Industry, Member of the Higher Council of Public Instruction and of the Consulting Committee of Arts and Manufacture. He had reached the age of sixty, but was in the enjoyment of full health and vigour.

CORRESPONDENCE.

ESTIMATION OF SULPHUR IN IRON AND STEEL.

To the Editor of the Chemical News.

Sir,—In the Chemical News (vol. lviii., p. 59) there appears a letter from Mr. J. Jas. Morgan, in which he disputes a statement made by the authors that a colorimetric method for the estimation of sulphur in steel (devised by Mr. Parry and published by Mr. Morgan in the Chemical News, vol. lvi., p. 13), does not admit of accurate comparison with the standards, owing to a portion of the PbS formed precipitating. In his quotation are substituted for an illustrative percentage, 0·05, the figures 0·03. The authors can only reiterate their experience of the method.

Mr. Morgan states under three heads the causes which, in his opinion, led to the failure of the authors to obtain accurate results. We repeat our statement that the process was carried out under the "*prescribed conditions.*" The solutions were not hot, nor even warm. The comparisons were made at once. The acetate solution was of the exact strength recommended by Mr. Morgan. In their own method the authors specify cold solutions and rapid comparison, whereas Mr. Morgan laid no stress on these points in the article which he published. If it is claimed that the latter will distinguish a steel containing 0·025 from one containing 0·05 per cent, the authors do

not dispute for a moment that such is the case, but a nearer approximation than this cannot be relied upon,* whereas the authors' method gives results much nearer the truth.

Messrs. Parry and Morgan evolve a small volume of H_2S into a flask without any attempt to remove the air, and the oxygen in the latter is thus in contact with the H_2S both in the flask and during its passage through the acetate solution, under which conditions the danger of a variable decomposition of the H_2S is obvious.

The cause of the precipitation is the motion communicated to the liquid by the passage of the evolved gases. In addition to particles of PbS suspended in the liquid, the end of the inlet tube and the surface of the Nessler tube at the point of contact of the liquid with the air are always coated with PbS.

The authors agree with the statement that the principle involved in both methods is the converse of that used for the estimation of lead in water; but in the method described by Mr. Morgan the conditions necessary to obtain reliable results are departed from. In the authors' process these conditions are strictly adhered to. Few chemists would attempt to determine the lead in water by producing the colour with a stream of H_2S gas. A small volume (2 c.c.) of a strong solution is invariably used by experienced water analysts.

However, the approximate colorimetric method detailed by the authors was of very secondary importance compared with their volumetric process headed "Method II." This method, without loss of accuracy, yields in two hours a result hitherto occupying two days to obtain.—We are, &c.,

J. O. Arnold.
Henry J. Hardy.

The Laboratory, Bank Street,
Sheffield, August 7, 1888.

* It is not, however, possible to distinguish with certainty a steel containing 0·10 from one containing 0·125 per cent.

ESTIMATION OF TANNIN.

To the Editor of the Chemical News.

Sir,—In the estimation of tannin in barks and bark extracts by the "gelatin process" is it not possible that erroneous results may be obtained by the presence of iron in the solution? I find that if potash alum be added to a watery solution of gelatin and then ferric chloride added, that a gelatinous brown precipitate is formed, and that the solution has no colour, but is quite clear, thus showing that no iron is in the supernatant liquid. What is this precipitate and what is it caused by?—I am, &c.,

"Young Analyst."

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of emperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 4, July 23, 1888.

Remarks on the Determination of Nitrogen in Vegetable Soils.—M. Berthelot and G. André.—The authors conclude that in a soil poor in nitrates the determination of nitrogen by means of soda-lime may be executed at once with safety.

Analysis of the Water of the Nile.—A. Muntz.—This analysis refers merely to the proportion of nitrogen present as nitrate, which is not high. The greatest quantity found was 4·09 m.grms. nitric acid per litre, corresponding to 7·62 m.grms. potassium nitrate, a quantity which falls short of the values found for other rivers. Boussingault has found 11 m.grms. potassium nitrate per litre of Seine water. It does not, therefore, seem that the nitrates contained in the water of the Nile can be regarded as the principal cause of the fertility of Egypt. Its power of producing a succession of abundant harvests must be sought in the deposits of mud.

Researches on Some Salts of Rhodium.—E. Leidié.—The author describes the double ammonium-rhodium chloronitrate, rhodium sesquisulphate, and the double rhodium-potassium, rhodium-sodium, rhodium-ammonium, and rhodium-barium oxalates.

A New Method of Determining Lithium by Means of Fluorides.—A. Carnot.—The spectroscope gives valuable indications for the qualitative detection of lithia, but a comparison of the intensity of the spectral rays gives merely a doubtful approximation as to the proportion of the metal, especially if more than a few m.grms. per litre are present. The reagent used is ammonium fluoride. As the commercial salt is often contaminated with fluosilicate it is purified as follows:—Some grms. of the salt are dissolved in a small volume of water, a double volume of ammonia is added, the whole is boiled for a few seconds, let cool, filtered, and washed with ammonia. The silica is thus eliminated and we have the fluoride in a strong ammoniacal solution, which is preserved in a covered platinum crucible. If we have in solution a few decigrms. at most of a salt of lithium with quantities of other alkaline salts not more than ten or fifteen times greater, we operate as follows:—The solution is reduced to a few c.c. in a tared platinum capsule; ammonium fluoride and an excess of ammonia are added up to a volume of 15 to 20 c.c. The whole is well mixed and let settle, when there is formed a white gelatinous precipitate, scarcely visible, of lithium fluoride, which partly adheres to the bottom of the capsule. The next day it is complete, when we decant almost all the liquid upon a very small filter and pour in its place a few c.c. of ammoniacal water and ammonium fluoride, stir up with a platinum spatula and let settle. Soon afterwards we make a second and a third decantation and wash the filter with a few drops of the same reagent. Thus we remove all the soluble alkaline salts, and we have, partly on the filter and partly in the capsule, all the lithium salt imbued merely with ammonia and ammonium fluoride. The volatile matter is expelled at a very gentle heat, the filter is burnt, the ash treated with a few drops of dilute sulphuric acid, and all the liquid is collected in the tared capsule. It is evaporated and ignited gently until all acid vapours have completely disappeared and the residue is weighed as neutral lithium sulphate. To take account of the solubilty of lithium fluoride in the ammoniacal liquid its total volume is measured, ranging from 30 to 50 c.c. According to former results, and remembering that the washing waters remained in contact with the precipitate for a short time only, we may admit that 10 c.c. of the liquid contains approximately 2 m.grms. lithium fluoride = 4 m.grms. sulphate or 1 m.grm. lithia. The quantity thus calculated is added to that weighed directly.

Certain Hydrates of Potassium Ferrite Crystallised in the Dry Way.—G. Rousseau and J. Bernheim.—The authors establish the existence of three successive hydrates, characterised by their different dissociation-tensions.

Determination of Glycerin by Oxidation.—V. Planchon.—The author notices the extreme ease with which this substance is completely burnt by potassium permanganate in an acid solution, being converted into water and carbon dioxide according to the equation—

$$C_3H_8O_3+7O=3CO_2+4H_2O.$$

He mixes 100 c.c. of a solution containing 0·5 grm. glycerin with 4·2 grms. of powdered permanganate, and 100 c.c. of water containing 15 grms. sulphuric acid. On

heating gently, carbonic acid begins to escape about 40°. At higher temperatures the escape is more abundant, and at 100° the total carbonic acid is eliminated.

On Yttrium and Sodium Chloride, Bromide, and Sulphide.—A. Dubois.—A study, chemical and optical, of anhydrous crystalline yttrium chloride, of the corresponding bromide, and the crystalline double yttrium and sodium sulphide.

On Anagyrine.—E. Hardy and N. Gallois.—Anagyrine is the active principle of *Anagyris fœtida*, a poisonous plant growing in Algeria. Anagyrine is an amorphous yellow substance, soluble in water, alcohol, and ether. With acids it forms definite crystalline salts, and gives precipitates with mercuric chloride, and with gold and platinum chlorides. In warm-blooded animals it produces vomiting, shivering, slackening of the respiratory movements, and ultimately stoppage of the heart.

Action of Aniline upon Epichlorhydrine.—Ad. Fauconnier.—In a former memoir the author described an oily base which he had obtained by the reaction of these two bodies, the hydrochlorate of which answers to the formula $C_{15}H_{20}N_2Cl_2O$. He has since obtained this compound in a crystalline state, and assigns to it the formula $C_{15}H_{18}N_2O$. He regards it as an alcoholic hydroxyl, possessing at the same time twice the function of a secondary base.

Constitution of Spongine. — Pierre Zalocostas.—Spongine is the nitrogenous organic matter of sponges. It approaches closely in its constitution to the collagenous bodies.

Volatile Bases of Cod-Liver Oil, Butylamine, Amylamine, Hexylamine, and Dihydrolutidine.—Arm. Gautier and L. Mourgues.—The authors give a description in detail of the above-mentioned bases. They remark that dihydrolutidine is moderately poisonous.

Neutralisation of Malonic Acid by Soluble Bases.—M. Massol.—The author's results show that the neutralisation-heats of malonic acid are lower than those of oxalic acid, but higher than those of succinic acid.

Preparation and Properties of Ethyl Fluoride.—H. Massan.—The author remarks that hitherto no researches of moment have been published on the fluorine compounds of the fatty series. Ethyl fluoride is a combustible gas, burning with a blue flame if pure. A trace of ethyl or methyl chloride gives the flame a green colour. In the combustion of ethyl fluoride there are produced copious fumes of hydrofluoric acid, which corrode the tube. In presence of an excess of oxygen it detonates violently on contact with a flame. If heated to 100° in a sealed tube, along with a very dilute solution of potassa, the compound is decomposed, yielding potassium fluoride, alcohol, and ether.

Acid Dimethyl-aniline and Diphenylamine Sulphates. General Reaction of the Acid Sulphates of some Aromatic Bases.—Leo Vignon.—The formation of the monosulpho-conjugated acids of dimethyl-aniline and diphenylamine obtained on heating the acid sulphates of these bases to 180° to 190° for two hours constitutes a general reaction. Under the same conditions acid aniline sulphate is transformed almost quantitatively into sulphanilic acid.

Formation-Heats of the Isomeric Bases Toluidine, Benzylamine, and Methyl-aniline.—P. Petit.

Polybasic Glycerinates. — M. de Forcrand. — These two thermo-chemical papers do not admit of useful abridgment.

Zeitschrift fur Analytische Chemie.
Vol. xxvii., Part 1.

Determination of the Ferric Oxide in Iron Ores by the Tartaric Method.—L. Blum.—The author proceeds as follows :—4 to 5 grms. of ore are dissolved. After separating the silica the liquid is diluted to 500 c.c. in a measuring flask and 50 c.c. are drawn off with a pipette for the determination of the iron. This portion is mixed with so much tartaric acid that no precipitate may be formed on the addition of ammonia. It is then diluted with water and precipitated with ammonium sulphide. The iron sulphide filtered off is washed with water containing ammonium sulphide, dissolved in dilute hydrochloric acid, precipitated with ammonia, filtered, and weighed as ferric oxide. Discrepancies between the results of identical samples may occur in consequence of the presence of phosphoric acid and magnesia. To prevent such errors the iron sulphide is precipitated in heat from a very dilute solution, and it is allowed to settle in heat, half an hour being sufficient.

Volumetric Determination of Sulphuric Acid.—A. Gawalowski.—The author's method, like those of C. Mohr and A. Clemm, is founded on the transformation of the sulphates by an excess of barium chloride, titrating back the excess of barium by means of an alkaline carbonate. The requisites are the solution of a barium salt, and that of an alkaline carbonate. These solutions are standardised by means of the solutions of a sulphate of known composition, and an indicator which is sensitive to alkaline carbonates. The solutions may be normal, semi-normal, or deci-normal. The sulphate to be analysed, which is necessarily neutral, is dissolved in water. An acid salt, or one containing free sulphuric acid, must be neutralised, and if the solution is alkaline it must be neutralised with hydrochloric or nitric acid. Of saline solutions a quantity is used, representing 0·5 of the dry substance. Phenolphthalein is added (except the ammonia is present), and the solution is afterwards neutralised, if requisite. An excess of the barium solution is then added, say 1 to 1·5 c.c. of the semi-normal barium solution to 1-10th grm. of the dry substance diluted with 30 to 40 c.c. of distilled water, well stirred, let stand from fifteen to thirty minutes, mixed with a few drops of pure alcohol, and titrated back with the soda solution until there appears a distinct permanent rose colour. The titration is best performed in an Erlenmeyer flask set upon blue paper. If ammoniacal salts are present the author uses lacmoid as indicator, and conducts the titration in monochromatic light.

The Oil of the Seeds of Jatropha Curcas.—F. M. Horn.—This oil is now (*Chemiker Zeitung*) used for burning, soap-making, adulterating olive oil, and probably for the preparation of alizarin oil. It is distinguished from castor oil by being almost insoluble in alcohol by its lower specific gravity and by its higher saponification and iodine number.

Detection of Fahlberg's Saccharine in Articles of Food.—E. Börnstein.—A sensitive reaction may be founded upon an observation communicated by Prof. Ira Remsen in the *American Chemical Journal*. On heating ortho-sulphobenzoic acid with resorcine and sulphuric acid there is formed a compound analogous to fluorescein. A small quantity of saccharine heated with a slight excess of resorcine and a few drops of strong sulphuric acid in a test-tube turns yellow, red, and then dark green, gives off sulphurous acid in plenty, and enters into vigorous ebullition, which continues for a short time after the removal of the flame. This ebullition is reproduced twice more, the liquid is let cool, diluted with water, and supersaturated with alkali, yielding a solution reddish by transmitted light, and displaying a strong green fluorescence by reflected light. This fluorescence is so sensitive that, in presence of 0·001 grm. saccharine the liquid can be diluted to 5 to 6 litres without the recognition of the fluorescence being in the least interfered with. The saccharine is best extracted from articles of food by means of ether. Solids and sparingly soluble substances are pulverised, moistened with a few c.c. of dilute sulphuric or phosphoric acid, dried, and exhausted by shaking with ether in a closed vessel. Fatty matter, if present, must first be removed by treatment with petroleum ether.

MISCELLANEOUS.

The Rarer Minerals.—At a recent meeting of the New York Microscopical Society, Mr. George F. Kunz, the able mineralogist of Messrs. Tiffany and Co., of New York, exhibited sand from Brindletown, Burke Co., N.C., containing monazite, which is a phosphate of cerium, lanthanum, didymium, and thoria, of which it contains from 0 to 17 per cent, and also exhibited monazite sand from Caravelhas, Brazil. He stated that the demand for these minerals had greatly increased of late, owing to the rare earths—zirconia, thoria, glucina, &c.—which they contain, and which are now used for the mantle or hood of the new incandescent gas burner invented by Dr. Carl Auer, called the "Welsbach" light. This increased consumption has led to a search by the collectors and dealers in England, Germany, France, Russia, Norway, and Brazil, and more especially in the United States, and so thorough has the search been that the prices of minerals which were considered rare a short time ago are now quoted at one tenth to one-hundredth of former figures. The minerals containing these earths are—Lanthanite, sipylite, tysonite, uranothorite, orangite, thorite, clevite, beryl, yttrotantalite, alvite, erdmannite, cerite, monazite, xenotime, fergusonite, æschynite, allanite, zircon, eudialyte, euxenite, samarskite, gadolinite, and bodenite. Of these beryl, cerite, monazite, xenotime, allanite, and zircon have been obtained in large quantities. Sipylite, orangite, and thorite are especially sought for. Monazite has been found at the following localities:—At Villeneuve, Ottawa County, Canada, a crystal of 14½ pounds; Aiexander County, N.C., at Milholland's mill; Amelia County, Va., in 20-pound crystals; Norwich, Conn.; Ural Mountains, Tavetch (var. turnerite), Mount Sorel (var. turnerite), Binnenthal, Switzerland, Southern Ural, River Samarka, Arendal, Norway, but at all these localities the occurrence is of mineralogical interest only. In Burk, Polk, and McDowell counties, North Carolina; at Glade Mine, Georgia, and at Caravelhas, Bahia, Brazil, it can be obtained in the form of sand in commercial quantities. In the North Carolina gold gravels of Rutherford, Polk, Alexander, Burke, McDowell, and Mecklenberg counties, monazite is found in considerable quantities in small brown or greenish or yellowish brown monoclinic crystals, associated with chromite, garnet, zircon, anatase, corundum, menacanite, xenotime, fergusonite, epidote, columbite, samarskite, and other materials. With these associations have been found several of the North Carolina diamonds, and from these localities will be furnished tons of monazite within the next twelve months. The Brazilian monazite is found at Caravelhas, Bahia, where its existence was made known about eight years ago by Dr. Orville A. Derby, geologist of Brazil. It occurs in large quantities as a beach sand almost free from other minerals, as if concentrated. As it occurs on the coast, it can easily be shipped directly to any point desired, and over 6 tons have already been sent to the United States. The Meredith Freeman estate on Green River, Henderson County, North Carolina, is one of the best zircon localities, and for twenty-five years was in the hands of Gen. T. L. Clingman, who mined 1000 lbs. in 1869, believing firmly in the incandescent properties of zircon. Unfortunately for him, when the time for utilising this mineral had at last arrived, Gen. Clingman had forfeited his leases. At Anderson, in Anderson County, S.C., zircons are found in immense quantities loose in the soil, under similar conditions to those in North Carolina; they evidently come from a decomposed felspathic rock. The crystals are generally remarkable for their perfection, weighing occasionally several ounces. The recent demand has also brought to light the existence of enormous quantities of zircon in the Ural Mountains and in Norway. Although in Canada, in Renfrew and adjoining counties, immense crystals have been found, single crystals being up to 15 lbs. each, yet they are so isolated that it would be impossible to obtain them in any quantity. As already stated, the use of the Welsbach incandescent light has created a new demand for these minerals, and with rare prudence the parties interested quietly gathered a stock before the demand was generally known. It is said that there have now been accumulated more than 25 tons of zircon, 10 tons of monazite, 6 tons of cerite, and thousands of pounds of samarskite and other minerals. As a consequence zircon is now offered at less than 10 cents a pound, monazite at 25 cents, and samarskite at 50 cents, and many of the uncommon minerals at equally low rates. It is said that the zirconia in one ton of zircon would, if used alone, make half a million Welsbach burners, but several other minerals are mixed with it to produce varied and beautiful effects of colour in the light.—*Engineering and Mining Journal.*

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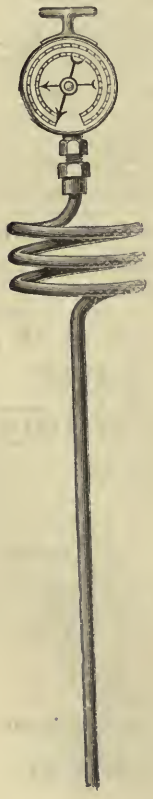

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1499.

CONTRIBUTIONS TO A KNOWLEDGE OF THE RARE EARTHS WHICH PRODUCE ABSORPTION-SPECTRA.

By PAUL KIESEWETTER and GERHARD KRÜSS.

The following researches are especially interesting as affording a decisive, though unconscious, verification of the results of Mr. Crookes, as it will be shown below.

These earths are found to consist of a far larger number of components than it would appear from the investigation of Soret, Lecoq de Boisbaudran, and Auer von Welsbach. The spectroscopic examination of the several fractions obtained by the fractionated decomposition of the nitrates from the earths of Fergusonite and Euxenite, has shown the difficulty of completely resolving the whole dydymia and erbia into their several ingredients by the means hitherto employed. We may approach more closely to the object aimed at if we observe that nature has deposited some of these constituents either together or partially separated in one or other minerals, and in this or that locality. Thus from the author's former researches it appears that the minerals contain only the elements :—

Thorite from Brevig..	$X\alpha$, $X\delta$, $X\eta$.
Thorite from Arendal	$X\beta$, $X\gamma$, $X\epsilon$, $X\zeta$, $X\eta$.
Wœhlerite from Brevig	$X\gamma$, $X\zeta$, $X\eta$.
Cerite from Bastnäs	$X\alpha$, $X\eta$.
Fergusonite from Arendal	$X\beta$, $X\gamma$, $X\delta$, $X\epsilon$, $X\zeta$, $X\eta$.
Fergusonite from Ytterby and Euxenite from Hitterö and Arendal	$X\alpha$, $X\beta$, $X\gamma$, $X\delta$, $X\epsilon$, $X\zeta$, $X\eta$.

Thus nature has already effected a partial separation of these mutually approximating elements, and in order to utilise this circumstance as far as possible in the study of the rare earths it is necessary to make an extensive spectroscopic investigation of the basic constituents of rare minerals from the most different localities. The following experiments have been undertaken from this point of view. The following minerals were examined :—

Yttrotitanite or Keilhauite from Arendal.—Dark brown pieces of keilhauite with vitreous cleavage-surfaces, in part with crystalline planes of a fatty lustre, were finely powdered and fused in a graphite crucible in a Perrot furnace with four parts of a mixture of sulphur and soda. This was done to search for germanium, which was not present.

After the mass had been lixiviated the dried residue was fused with four parts of acid potassium sulphate, and the rare earths of yttrotitanite were obtained in the watery extract of the melt. After precipitation from a hydrochloric solution by means of oxalic acid the mixed earthy oxalates, after drying and ignition, left a greyish-white powder with a slight yellowish cast. The ignited oxides were gradually brought into perfect solution by repeated treatment with strong nitric acid, and heating almost to dryness. The nitrate obtained, after being taken up in water, was repeatedly concentrated for a considerable time upon the water-bath, so that no free nitric acid was present in the solution as finally obtained. This solution showed the spectrum given below.

It is to be noted that samarium does not occur among the keilhauite earths, and that in this mineral there have been found only eight constituents of the Di, Er, Tm, and X earth. This is a relatively small number if compared with that forming the highly complex earths of other rare minerals. The most intense lines were $Di\delta = 521{\cdot}5$ and $X\zeta = 452{\cdot}6$, whilst almost all the other bands were faint or very faint. The substances, $Di\delta$ and $X\zeta$, whose nitrates gave lines at $\lambda = 521{\cdot}5$ and at $\lambda = 452{\cdot}6$, will therefore probably be more easily isolated from the keilhauite earths than from those of other minerals.

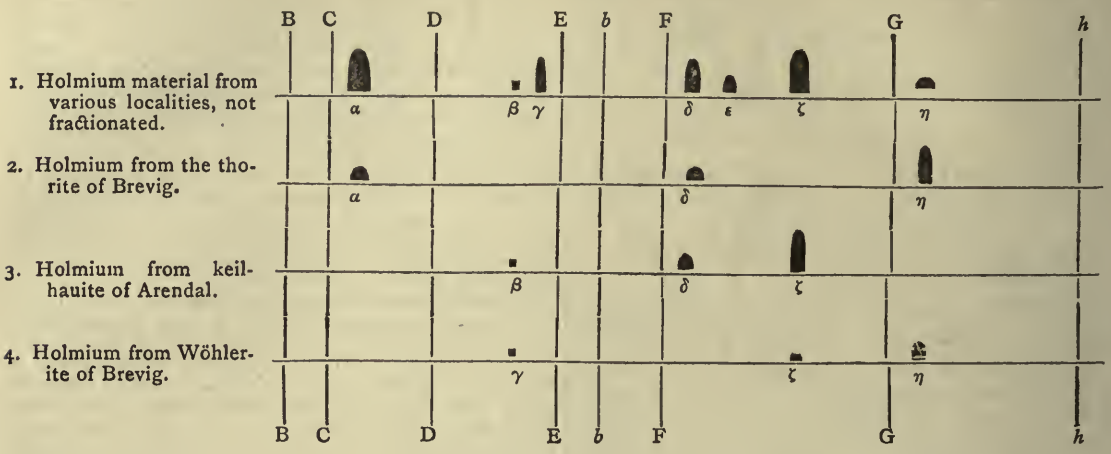
The isolated intense occurrence of the line $X\zeta$ is further noteworthy as affording further support for the view of Krüss and Nilson as to the complexity of Soret's earth, X. Let, *e.g.*, the keilhauite spectrum and that of the earths of the Brevig thorite and wœhlerite be compared with that of an ordinary holmium material ; it will then be seen that the holmium lines marked as X do not belong to the nitrate of one, but of several elements. This appears from the following diagram, in which are introduced in a scheme of the Frauenhofer lines on the one hand the X lines altogether, and on the other the X lines occurring in the spectrum of thorite (Brevig), wœhlerite, and keilhauite, according to their relative intensity. (See next page).

From this diagram it appears that the ingredients of the old holmium which occur in thorite, wœhlerite, and keilhauite differ from each other, whilst that body whose nitrate gives the line $X\epsilon$ does not occur in keilhauite and in the Brevig thorite and wœhlerite. This portion of Soret's X, according to the researches of Krüss and Nilson, is found in thorite, fergusonite, and euxenite of Arendal, and in the fergusonites of Ytterby, and the euxenites of Hitterö.

As to the occurrence of didymium in keilhauite, according to the above measurements there was observed only the presence of the constituents $Di\gamma$ and $Di\delta$. As only the lines belonging to the nitrates of these bodies are present in the spectrum of keilhauite, we have here a further proof of the more complex nature of didymium. Thus, in the neutral solutions of the nitrates of the earths of Brevig thorite the $Di\gamma$ lines at $\lambda = 579{\cdot}2$ and $575{\cdot}4$ were rather faint and faint, whilst at the same time

Keilhauite from Arendal.

Observed Position of Maximum Darkness. Position of Drum.	Wave-length Observed.	Wave-length Observed by Krüss and Nilson.	For	Intensities of Absorption-bands.
421	683·1	684	$Tm\alpha$	Very faint ; identified as a Tm line by comparison with Tm from the thorite of Arendal.
519	654·4	654·7	$Er\alpha$	Faint.
863	580·3	579·2	$Di\gamma$	Rather faint.
895	575·3	575·4	$Di\gamma$	Faint, fainter than $\lambda = 579{\cdot}2$
1106	542·7	542·6	$X\beta$	Very faint.
1128	539·3	539·9	?	Very faint ; observed in the spectra of the holmium material, and identified by direct comparison.
1240	523·0	523·1	$Er\beta$	Rather strong.
1254	521·3	521·5	$Di\delta$	Strong, stronger than $\lambda = 579{\cdot}2$; a further proof of the difference of $Di\gamma$ and $Di\delta$.
1589	485·9	485·5	$X\delta$	Rather faint, but much stronger than $X\beta$.
2088	452·0	452·6	$X\zeta$	Stronger, stronger than $X\delta$.



the lines marked Diθ and Diι at λ=445·1 and 444·7 were very distinct. On the other hand, in the spectrum of keilhauite the Diγ lines were rather faint and faint, but the lines Dθ and Diι were not to be observed at all. This phenomenon could not occur if λ=579·2, 575·4, 445·1, and 444·7 belonged to the nitrate of one single element. Further evidence for the more complex nature of didymium may be drawn from the strong isolated occurrence of Diδ at λ=521·5. From the study of the spectrum of keilhauite may be drawn a number of proofs for the complexity of those rare earths which produce absorption spectra. Spectroscopic traces of uranium were found in yttrotantalite.

(To be continued).

ELECTRICAL DIALYSIS.

By H. N. WARREN, Research Analyst.

DURING some experiments on reduction by means of nascent hydrogen, I have lately endeavoured to expose the same to an electro-dialytic action for the purpose of converting one substance into an allied form by the aid of the nascent hydrogen thus evolved, and at the same time to effect a separation by means of dialysis.

The apparatus made use of consists of an ordinary tubulated phial, from which the bottom had been separated and replaced by a parchment diaphragm, the further end being furnished with a perforated cork through which was inserted a glass tube terminating in a point containing metallic mercury in direct communication with a platinum wire fused into the glass and projecting into the mercury. The extremity of the wire is attached to a platinum plate dipping into the second tube intended to receive the solution to be thus acted upon. The decomposing tube itself is supported in a third vessel, containing an aqueous solution of whatever substance is desired to combine with the one dialysed. The same vessel also contains a porous pot, partially filled with ammonium chloride, into which a zinc rod has been introduced, the extremity being furnished with a binding screw, and in connection with the positive pole of a constant battery, the small tube containing the mercury being likewise connected to the negative extremity of the same. Before using the apparatus care should be taken to see that the three solutions contained in their respective tubes are exactly the same height as regards their aqueous layers, otherwise secondary actions present themselves, and either considerably retard the action or render it useless. The apparatus being now in order, and connection having been maintained by the aid of a large Bunsen cell, employing acidulated water for the decomposing or inner cell, large volumes of hydrogen gas are at once evolved from the platinum plate; and if now the acidulated water is wholly transferred to the outer cell, or retaining vessel, and replaced by a solution of cupric sulphate in admixture with sodium chloride, a violent evolution of gas is, as before, set free, which quickly subdues, the hydrogen assuming a nascent state, and soon decolourising the solution, the product being metallic copper, which attaches itself firmly to the platinum electrode, while sodium sulphate is formed by mutual decomposition; this, being a crystalloid, rapidly dialyses into the acidified solution contained in the outer cell. A solution containing potassium dichromate, acidified with sulphuric acid, was also rapidly converted into potassium sulphate and chromic hydrate, the potassium salt separating itself as in the previous experiment. Also, on exposing a solution of potassium ferricyanide to a like action, a quantity of potassium ferrocyanide had collected in the outer cell. Various organic substances were also thus treated, among which may be mentioned an alcoholic solution of ricinoleic acid, the outer cell containing sodium carbonate, the oleic acid becoming almost entirely converted into stearic acid, and combining with the sodium carbonate, thus liberating its carbonic acid, and forming sodium stearate.

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DR. PETERS'S AMERICAN METHODS OF COPPER SMELTING.
THE VALUATION OF FURNACE MATERIAL.

By JAMES W. WESTMORELAND, F.I.C.,
Associate of the Royal School of Mines, London.

IN the review of the above work which appeared some time ago in the CHEMICAL NEWS, vol. lvii., p. 22, certain statements are made, regarding which I will, with your permission, make a few observations.

Dr. Peters, in speaking of the English or Cornish system of fire assay, states that "in spite of the decided and constant inaccuracy of its results, it is so interwoven with the commercial customs of the Swansea copper smelters, and its replacement by one of the more accurate wet methods would involve such a revolution in the price lists and methods of ore buying, that it is likely to maintain its sway in the great ore market of the world for an indefinite time," while other recent writers have compared the fire assay to "a miniature of the smelting and refining operations which the ore has to be subjected to,

and is therefore a fairly practical method of arriving at its market value."

It is, of course, impossible to say when the Swansea fire assay will be replaced by more accurate wet methods of testing, but the other statements relating to the customs of the ore market are more open to criticism. Dr. Peters states that the adoption of a wet assay basis would cause a revolution in the price lists and methods of ore buying. But what are the facts? The Swansea ticketings or price lists are now things of the past, furnace material being now sold at a fixed price per unit of copper by private treaty. The remaining customs of the ore trade are:—The fire assay basis for percentage; ore tons of 21 cwt. 24½ lbs. (equal to 2376½ lbs. avoirdupois) in place of the statute ton of 2240 lbs., and an allowance of the actual moisture present in the mineral, which is invoiced and assayed in the dry state. But since July, 1886, the ton of 2376½ lbs. has to some extent been abandoned, sales of Annaconda matte being made on the actual dry weight of the parcel in pounds avoirdupois, the copper contents being invoiced at per pound of fine copper present in the parcel; a simple calculation showing the relation between the old and new systems of invoicing, a table being also drawn up showing the equivalent prices by each method. The only change really involved in a wet assay basis, therefore, would be the substitution of a more accurate process of assay with a fixed and definite "margin," or allowance, in place of the present inaccurate and unreliable fire assay method.

But serious errors have been made by other recent writers who have compared the fire assay to a miniature of the smelting and refining operations which the ore has to undergo, and which is therefore assumed to be a fairly practical method of arriving at its commercial value. The most elementary knowledge of metallurgy and assaying should have prevented such a comparison being made; the processes have little or nothing in common, and in recent years this view of the fire assay has certainly been kept in the background. The fusion for regulus, calcination, fusion for coarse copper, and refining, are in the fire assay entirely different operations to those conducted on a large scale, while the influence of "mass" has a most important bearing both on the fire assay and the furnace yield; for example, fire assay tests conducted with half and whole trial (200 and 400 grains) portions invariably show a higher percentage of metal on the heavier test, while carefully conducted chemical tests with similar portions of mineral will give practically identical results. Again, two fire tests made on the same finely pulverised sample by the same individual assayer gave 33 per cent and 35⅝ per cent respectively, equal in money value to £643 and £694—a difference on the parcel of £51. Will anyone contend that results of this character can give any practical indication of the market value of a parcel of mineral.

It is impossible to enter into all the phases of this question within the limits of this article, but it may practically be said:—That the results of the fire assay are very inaccurate and irregular, duplicate assays by the same operator varying considerably; that the margin between the fire and wet assays is extremely variable, and can be varied to a great extent at the will of the assayer; that the fire assay, when applied to the examination of bar coppers, will not detect or condemn impure coppers containing arsenic and antimony in large proportions; or confirm the quality of pure metals. Again, it has been admitted by the smelters that the results of fire assays are distinctly below the furnace yield; and by reason of these defects I contend that the process cannot form the basis of an equitable contract for the sale or purchase of furnace material.

Again, the great uncertainty of the process is well known to vendors and purchasers of mineral, the result being that extreme pressure is often brought to bear on the assayers with regard to the produce they shall return, and in fact the skill of an assayer is judged simply by the greater or less margins between the fire and wet assays which he is able to obtain for his principals, according to whether they are purchasers or vendors. This, again, has resulted in actual tampering with the results of wet assays, in some cases to mislead principals regarding the actual "margin" on parcels of material; and again, to mislead assayers regarding the margins they were obtaining on material in process of testing.

I have always contended that it is most dangerous to admit the principle of interfering with the indications of any test; vendors and purchasers should meet each other fairly and fight out the question of price. When this has been settled, the true produce of the mineral should be ascertained without reference to any other consideration, for when once interference begins different vendors and purchasers of mineral exercising varying amounts of influence render the method of valuation inequitable.

As I write, I have the results of a series of tests of 20 parcels of the same material before me, and the differences between the fire and wet assays are so extremely variable that the fire assay produces cannot, in any sense, indicate the true value of each parcel. At the same time I must admit that until recently the wet assay tests made by many English operators were a reproach and a disgrace to the persons concerned—these bad results being, in the majority of cases, obtained by the "cyanide" method of testing, a process which is now, I believe, going into comparative disuse.

But, in the section of Dr. Peters's work relating to sampling and assaying, four methods of testing are described, which are, he states, quite sufficient for any technical or commercial laboratory, and yet that are every one essential if it be desired to fulfil every condition to the best advantage. These methods are the cyanide assay, colorimetric determination, precipitation with zinc or iron, and the electrolytic assay.

Little need be said regarding Dr. Peters's description of the cyanide assay, except that he states nothing which is unknown and omits much that is known to English chemists regarding the method, while the colorimetric and precipitation methods are only used to help other processes over some difficulty. But when we come to Dr. Peters's eulogistic description of the electrolytic assay, the statements he makes regarding it deserve careful consideration. He describes the method as being suitable for *nearly* every class of material and every percentage of copper, from the highest to the lowest, and, owing to its extreme accuracy, as largely supplanting the ordinary analytical methods. But, while making these statements, he quotes the results of Messrs. Torrey and Eaton, who have shown that silver, bismuth, lead, and arsenic all interfere with the accuracy of the method, and in these cases it is recommended that the deposited metal should be re-dissolved and the percentage of pure copper determined by that most objectionable of all methods of testing, the cyanide assay. But, in addition to the above impurities, the writer has met with cases where *tin* has been deposited with the copper, where flakes of oxide of manganese, a common constituent of American mattes, have been weighed with it, while ferric salts, which in many cases form the greater part of solutions of copper minerals, have a most injurious influence in delaying the precipitation of the metal.

Other evidence regarding the doubtful value of the electrolytic assay will be found in a paper entitled "A Comparison of Various Methods of Copper Analysis," by W. C. Eustis, Boston, Mass. (*Transactions of the American Institute of Mining Engineers*, vol. xi., p. 120), in which the results of a number of American analysts operating on an artificial mixture are given, together with the methods of analysis employed. Here evidence is given in a letter from Mr. Thos. B. Stillmann, of the deposition of other metals with the copper, while other chemists use various methods for testing the purity of the metal and for estimating the traces of copper generally left unprecipitated by the current. Again, Claussen (*Journal of the Society of Chemical Industry*, vol. vii., p. 402, May,

1888) treats the electro-deposited metal with a solution of bromine in hydrochloric acid to remove any arsenic, afterwards electrolysing the purified solution, while Bayley (*Industries*, 1887) advocates the use of sulphuretted hydrogen to estimate the small amount of copper generally left undeposited by the current. The writer admits that copper may be precipitated with accuracy from solutions, provided no interfering metals are present; but if this separation is absolutely necessary to avoid erroneous results the method is decidedly inferior to another well-known process to which allusion will presently be made.

Dr. Peters's evident satisfaction with the electrolytic assay will be apparent from the following quotation:—

"The following figures were handed to the author by a friend who was desirous of testing the accuracy of this assay, and who made seven determinations on the same sample of ore, weighing out different quantities in each case in order to obtain varying figures in the calculation of the percentage. The ore was an impure tetrahedrite, or the results would doubtless be even closer:—

(1) 9·66	(5) 9·98
(2) 9·67	(6) 9·85
(3) 9·74	(7) 9·82
(4) 9·61	

"It is evident that these results owe their remarkable uniformity to extreme care in manipulation and to the employment of the most perfect apparatus."

A friend to whom the above figures were communicated suggested that if the above figures are satisfactory it would be desirable to know what results Dr. Peters would consider unsatisfactory, and my personal opinion is that the results are neither creditable to the method employed nor to the operator concerned.

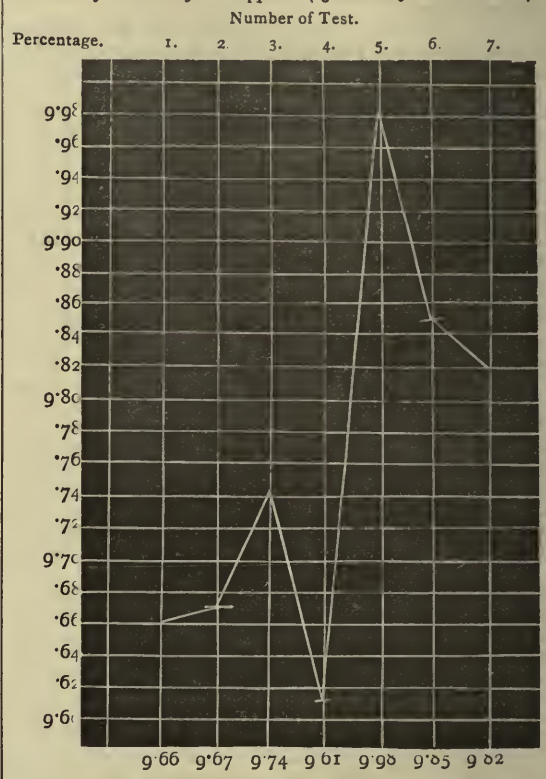
But Dr. Peters omits to mention a method of determining copper which day by day is coming into extended use in England. It is adopted by the principal analysts, in many copper smelting works, in works where wet extraction methods are employed, and it is equally applicable to the determination of copper in refined metals, almost chemically pure, and purple ore or blue billy with under one-tenth of one per cent of copper. Moreover, it unaffected by the presence of silver, arsenic, bismuth, zinc, or manganese, while a simple method of separation by precipitation with hyposulphite of soda will separate the metal sufficiently from any conceivable combination of impurities to enable it to be at once accurately determined. I refer, of course, to E. O. Brown's iodide process, which was devised over thirty years ago for the examination of refined copper.

A large number of experiments made by me to ascertain the non-interference of various metals, are published in the *Journal of the Society of Chemical Industry*, February, 1886; while the accuracy of the process is referred to in more or less detail in the latest editions of Sutton's "Volumetric Analysis," Dittmar's "Quantitative Analysis," Phillips's and Bauerman's "Elements of Metallurgy," Mitchell's "Manual of Assaying," and in some articles on Assaying by T. Bayley, *Industries*, 1887. Curiously enough, none of the writers I have quoted recognise the importance of the titrations being made in an acetic acid solution, although they mention the advisability of this course. It is necessary to avoid the interference of arsenic acid, generally present to a greater or less extent, which would in the presence of mineral acids liberate iodine and vitiate the copper assay; while in an acetic acid solution, no such interference occurs.

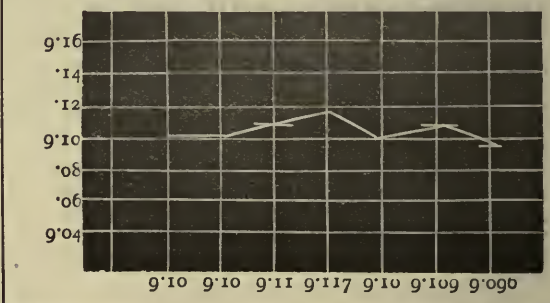
But after reading Dr. Peters's eulogy of the electrolytic method as a matter of curiosity I made seven experi- similar to those quoted by him in order to see what the iodide process was really capable of doing.

A sample of finely pulverised cupreous pyrites was taken, and seven portions (50, 60, 70, 80, 90, 100, and 110 grains) dissolved in acids in the usual manner. Solutions of the following metals were then added to each test till

Electrolytic Tests for Copper. (Quoted by Dr. Peters).



Iodide Tests. (J. W. Westmoreland).



the undermentioned percentages of impurities were present.

Tin	2·00	per cent.
Antimony	2·00	"
Bismuth	2·00	"
Lead	5·00	"
Arsenic	5·00	"
Zinc..	5·00	"
Manganese	3·00	"
Nickel	3·00	"
Silver.	0·50	"
Ferric salts	A large percentage	

These impure solutions were then tested in the usual manner for copper ores, mattes, &c., and the following results were obtained:—

(1) 9·10	(5) 9·10
(2) 9·10	(6) 9·109
(3) 9·11	(7) 9·096
(4) 9·117	

Highest result	9·117	per cent.
Lowest ,, ...	9·096	,,
Difference ..	0·021	,,

Electrolytical Results Quoted by Dr. Peters.

Highest result	9·98	per cent.
Lowest ,, ...	9·61	,,
Difference ..	0·37	,,

At the present price of this material, about 14s. 6d. per unit, the difference in value between the maximum and minimum results quoted by Dr. Peters as electrolytic assays, would be nearly 5s. 6d. per ton of mineral, while the difference in value by my iodide results is less than fourpence.

The following diagrams, both drawn to the same vertical and horizontal scales, also show the relative accuracy of the results quoted by Dr. Peters and myself:—

It would certainly be interesting if any advocates of the electrolytical, sub-sulphide, cyanide, or other methods of determining copper would operate on similar solutions to those I have described above, and publish their results; at present I have the greatest doubt if concordant and accurate results can be obtained by other processes. The following tests also show the unreliability of the electrolytic assay:—

Copper Ore.

Electro-deposition direct	5·39
,, after separation of As, Bi, Ag ..	5·10
Iodide process (J. W. W.)	5·09
Ditto. Result, obtained at an interval of six months in another laboratory, different operators, reagents, and apparatus. Test made without separation of Bi, As, Ag	5·12

Electro-deposition Direct.	Deposited Metal Dissolved and Tested by Iodide Process.	Iodide Process.	Electro-deposition from Purified Copper Solution.
91·05	90·90	—	—
91·48	91·16	91·15 / 91·16	—
75·02	74·73	74·73	—
65·76	65·46	65·52	—
91·70	91·25	91·25	—
61·52	60·34	60·28	—
61·28	—	60·37	—
61·11	60·11	60·11	60·07

Practically, therefore, the introduction of a wet process of assaying would not interfere with any custom of the ore-trade; but if such a process was introduced, the iodide method would form a much more reliable basis than the electrolytic assay.

Leeds, August 2nd, 1888.

A NEW CONDENSER ATTACHMENT.

By JOSEPH F. GEISLER.

The condenser attachment consists of a bulb-shaped cylinder about 2½ inches in diameter and 4 inches in length (exclusive of lower contracted portion to fit into the stopper of the percolator containing the extraction tube), into the neck of which a tube (1 inch in diameter) containing a syphon, is attached by fusion. The tube reaches well down into the cylinder, and is perforated above the height of the syphon to admit the vapours into the condenser. The inner end of the syphon reaches very near to the bottom of the tube, and thus will thoroughly drain the same. The condenser attachment, made for me by Eimer and Amend, delivers about 15 c.c. of solvent at each syphoning, which is the most suitable quantity for ordinary work. Any desired quantity of solvent can be delivered by increasing the size of the reception tube, or raising the height of the syphon, in which case the size of the extraction tube must also be increased to hold the increased quantity of solvent. The solvent drops from the condenser into the bulb-shaped attachment, and is discharged periodically by the automatic syphon upon the substance contained in the extraction tube below. The condenser attachment is of special advantage in the extraction of crude drugs, fats, alkaloids, resins, or substances to be removed by volatile solvents, such as ether, petroleum ether, chloroform, &c. One objection to the ordinary extraction tube and percolator with condenser is, that the time of extraction is unnecessarily prolonged by the continual dilution of the solvent in the extraction tube by the condensed portions from the condenser before that already in the extraction tube has had time to drain off. The difficulty is obviated by the condenser attachment, for little of the condensed solvent will get into the extraction tube proper until the reception tube is filled to the bend in the syphon, when the tube empties itself. By a little care this can so be regulated that the solvent in the extraction tube is drained off before a fresh supply is syphoned into the same from the tube above. By keeping sufficient solvent in the lower flask or receiver there is no danger whatever of the material in the extraction tube becoming overheated and ejecting the solvent, when the latter is delivered upon the same. The inner tube of the Liebig condenser, used with this piece of apparatus, should have an internal diameter of $\frac{5}{16}$, or better, $\frac{3}{8}$ inch, and the lower end should be cut off obliquely. The following are the sizes of the different parts of the complete extraction apparatus, convenient and suitable for the needs of ordinary work:—

1. A 6 oz. Erlenmeyer flask.
2. Extraction tube, 1½ inches (inter. diameter) × 5 inches length.
3. Percolator, 1½ inches internal diameter × 7 inches for body of cylinder, exclusive of lower contracted end of about 2½ inches. Total length of percolator, 9½ inches.
4. Condenser attachment, size to deliver about 15 c.c. solvent.
5. Liebig condenser, about 15 to 16 inches in total length, with inner tube of $\frac{5}{16}$ to $\frac{3}{8}$ inch internal diameter, and lower end cut off obliquely.

—*Journal of the American Chemical Society*, Vol. x., No. 3.

THE CLASSIFICATION AND NOMENCLATURE OF METALLINE MINERALS.*

By T. STERRY HUNT.

(Concluded from p. 68).

In fixing the value of p for those metals which, like iron and chromium, like copper, mercury, gold, tin, palladium, and platinum, yield two distinct chlorides, we have in all cases taken the amount of metal which, in the ferrous, chromous, cuprous, aurous, stannous, palladous, and platinous compounds, is combined with one portion (35·5 parts) of chlorine. A similar rule, as already shown (§ 3), is applied in the case of arsenic, antimony, and bismuth. This unit-weight of the metal $=p$, when divided by d—the specific gravity, water $=1·000$—gives the value of v.

(1). The metals and their alloys, which we include in the tribe of the Metalloideæ, present, unlike the other tribes of the order, wide differences in hardness, condensation, fusibility, and chemical characters, which can now only be briefly noticed. Of the hard and less fusible metals, chromium, manganese, iron, nickel, and cobalt, with $p=26$—$29·5$, gives values for $v=3·4$—$3·6$; while the

* Read before the American Philosophical Society, May 4, 1888.

denser group of palladium, rhodium, and ruthenium, with $p=52—53$, and also the still heavier group of platinum, iridium, and osmium, in which $p=97—99$, agree in having $v=4·5—4·6$. The softer and more fusible metals, gold and silver, give $v=10—10·5$; the value of v for solid mercury being 13·9, for lead 9·2, for tin 8·0, and for cadmium, copper, and magnesium 6·5—6·9. With these, it is instructive to compare the values of v for the alkali metals, cæsium = 70, rubidium = 56, potassium = 44, sodium = 24, and lithium = 12; as also barium, strontium, and calcium, in which v is from 12·5 to 17·5.

(2). The tribe of the Galenoideæ is conveniently divided into the three sub-tribes of sulphides, selenides, and tellurides, which we designate Thiogalenoideæ, Selenogalenoideæ, and Tellurogalenoideæ. Of these, the first includes the typical genus Thionites, embracing the native sulphides of lead, silver, and copper, together with metacinnabar, stibnite, and bismuthite; having $H=2—3$: $v=7—8$. The sub-tribe of the Selenogalenoids includes a genus which may be called Eucairites, embracing besides eucairite (cuproso-argentic selenide) various other selenides of lead, silver, copper, mercury, and bismuth; $H=2—3$: $v=8—9·5$. The sub-tribe of Tellurogalenoids includes various tellurides of silver, gold, lead, mercury, nickel, and bismuth, with $H=2·5—3·5$: $v=8—10·5$, which we include in the genus Tellurites. The soft, flexible, foliated sulphides, like sternbergite, argyropyrite, friesite, covelline, and perhaps molybdenite, may constitute a second genus of the first sub-tribe with the name of Thiophyllites; while tetradymite and nagyagite perhaps may form a similar division of the Tellurogalenoids, as Tellurophyllites.

(3). In the third tribe we include many sulphides which are near in hardness, in condensation, and in other characters, to the last, and are chiefly sulphides of lead, copper, and silver united with sulphide of antimony, of bismuth, or more rarely of arsenic. The antimonial species of this tribe are represented by the well-known species, bournonite; from which the name of the tribe, Bournonoideæ, and the genus Bournonites; having $H=2—3·5$: $v=7—8·5$. The large group of bismuthic species, having similar values for H and v, and many other points of resemblance, of which emplectite is a representative, constitute the genus Emplectites. These two genera present instructive examples of progressive series, especially in the double sulphides of antimony and lead, $Sb_2S_3.nPbS$, in which n has values of 1, 2, 3, 4, 5, 6, and, in a related species, even equals 12. The species enargite is an arsenical bournonoid, and to this tribe may perhaps belong some of the forms of fahlerz or grey copper ore.

(4). The next three tribes are distinguished from the two preceding—which correspond to the Glances of the natural-history system—by their much greater hardness and condensation, and were included in the order Pyrites of the same system, but are here divided on chemical grounds. The tribe of the Pyritoideæ may be divided into two genera, the harder designated as Pyrites with $H=5·5—6$: $v=3·8—4·5$ includes cubic and prismatic iron pyrites, wth linnæite, siegenite, carrolite, and laurite; while the genus Pyritinus, $H=3·5—4·0$: $v=4·5—5·5$, embraces troilite, pyrrhotite, allabandite, millerite, pentlandite, chalcopyrite, cubanite, and probably stannipyrite.

(5). The tribe of Smaltoideæ includes the various arsenides of cobalt, nickel, and iron, of which leucopyrite and smaltite are representatives, and which we have included in the genus Smaltites with $H=5—6$: $v=3·6—4·5$. The arsenides of copper, with less hardness and a higher value for v, will form a distinct genus, Algodonites. Closely related to smaltites is the antimonial species, breithauptite; while the antimonoid of copper, horsfordite, and apparently dyscrasite, are near to Algodonites.

(6). The tribe of Arsenopyritoideæ, embracing the genus Arsenopyrites, includes the compounds of sulphide of arsenic with sulphides of iron, cobalt, and nickel, of which arsenopyrite or mispickel is a type, $H=5—6$: $v=2·9—3·5$. Near to these are some little known double sulphides holding antimony and bismuth, as ullmannite, corynite, alloclasite, and grunauite.

(7). Passing now to the sub-order Spato-metallinea, we have in the tribe Spato-metalloideæ those forms of phosphorus and of selenium which are wanting in the metallic characters, including the colourless and the ordinary red phosphorus, apparently two forms of selenium, and the various known species of sulphur.

(8). The tribe Sphaleroideæ includes the genus Sphalerites, embracing sphalerite, wurtzite, christophite, greenockite, hauerite, oldhamite, and cinnabar, having $H=2·5—4·0$: $v=6—7$. Here also belong the red antimony sulphide, metastibnite,* and the arsenical sulphides, realgar and orpiment.

(9). The tribe Proustoideæ includes the genus Pyrargyrites, under which we may include, in two sub-genera, both the arsenical and the antimonial red silver ores, including proustite, pyrargyrite, miargyrite, &c.; with $H=2—3$: $v=8—9$. In this tribe also are included the arsenical and the antimonial forms of fahlerz as members of a genus, Tennantites, in which, moreover, are placed binnite, dufrenoysite, livingstonite, &c., having—

$$H=3·5—4·5 : v=6·5—7·5.$$

The following table gives a synoptical view of the tribes and genera above proposed for the order of the Metallata. Further studies may probably show reasons for further sub-division of some of these genera and for the establishment of new ones.

Order *METALLATA.*

Sub-order A. METALLOMETALLINEÆ.

- Tribe 1. METALLOIDEÆ (Metals, alloys, metallic Se and P).
- „ 2. GALENOIDEÆ, including three sub-tribes:—
  - *a. Thiogalenoideæ;* Thionites, Thiophyllites.
  - *b. Selenogalenoideæ;* Eucairites.
  - *c. Tellurogalenoideæ;* Tellurites, Tellurophyllites.
- „ 3. BOURNONOIDEÆ; Bournonites, Emplectites.
- „ 4. PYRITOIDEÆ; Pyrites, Pyritinus.
- „ 5. SMALTOIDEÆ; Smaltites, Algodonites.
- „ 6. ARSENOPYRITOIDEÆ; Arsenopyrites.

Sub-order B. SPATOMETALLINEÆ.

- Tribe 7. SPATOMETALLOIDEÆ (Sulphur, non-metallic Se and P).
- „ 8. SPHALEROIDEÆ; Sphalerites.
- „ 9. PROUSTOIDEÆ; Pyrargyrites, Tennantites.

The writer has prepared tables, giving for each species in the order of the Metallata besides hardness, specific gravity, and crystalline system, the chemical formula, represented by a simplified notation, as indicated in § 3, together with the unit value for p, and the value of v calculated therefrom. For each species, moreover, besides its trivial designation, are given its generic and specific Latin names. Thus, for example, we have for the species above named under the genus Pyrites:—P. cubicus, P. prismaticus, P. cobalteus, P. niccolocobalteus, P. cuprocobalteus, and P. rutheneus; while the named species of Pyritinus are:—P. ferrosus, P. magneticus, P. manganeus, P. niccoleus, P. ferroniccoleus, P. cupreus, P. sub-cupreus, and P. stanneus. Again, the above-named species of the genus Sphalerites are:—S. zinceus vulgaris, S. zinceus hexagonus, S. ferrozinceus, S. manganeus, S. calcareus, S. mercureus, and S. stibeus. A similar task, except so far as regards generic and specific names, has already been accomplished for the order of the silicates in the essay published in 1886, already cited, and is now well

* The native red sulphide of antimony, Sb_2S_3, occurs abundantly as an amorphous deposit from thermal alkaline sulphurous waters, with sulphides of arsenic and cinnabar, at Steamboat Springs, Washoe County, Nevada, according to a private communication from Dr. G. F. Becker, who suggests the name of metastibnite.

advanced for most of the other orders. When completed the whole will be published with explanatory and critical details, as a Systematic Mineralogy, to be followed by a Descriptive Mineralogy.

ON THE

PRESENCE OF FUSEL OIL IN BEER.*

By WILLIAM M. HAMLET, F.C.S., Government Analyst.

THE beverages we know so well as fermented malt liquors are so complex in their composition, and so liable to change and decay, that until the last few years very little was known of their exact nature and internal constitution, —still everyone was supposed to know all along the difference between good and bad beer. From the time of Falstaff to the present day the beer drinker has always been a trifle suspicious of his brewer, and ever ready to exclaim with that fat and valiant judge of good liquor, "You rogue, here's lime in this sack," and he generally experiences a most lively satisfaction in changing his "barley bree."

It would help us to clearer views on this subject if we consider what beer really is, or rather what it ought to be, and what are the chemical and biological processes involved in its manufacture. I may therefore at once define beer as an alcoholic beverage made from malt, hops, yeast, and water.

As briefly as I can describe it, the process of brewing ordinary beer is as follows:—Malt is crushed between rollers, and dissolved in or extracted by water at a temperature which is more or less a secret with the individual brewer,—generally from about 140° or 145° to 150° F. By this means an infusion of malt is made, the operation being known as that of mashing; the vessel in which it is produced being termed the mash tun, while the product is known as the wort. The water found most suitable for mashing is one containing very little or no organic matter and a somewhat large proportion of sulphate of lime, which makes what is called a *hard* water: for porter brewing, however, a softer water is used. By using a hard water certain albuminous matters contained in the malt are prevented from coming into solution; that is, the albumenoids are rendered much less soluble.

The chief object of the brewer in mashing is to convert the starch present in the malt into a peculiar variety of sugar termed maltose, this change being effected by the presence of a body known as *diastase.* A very small amount of this diastase is sufficient to convert an unfermentable body like starch into maltose: 1 part will transform 10,000 parts of starch into maltose—a sugar which is directly fermentable.

The next step is to boil the wort in a separate vessel termed the copper, together with a certain quantity of hops. The object of adding the hops is to impart the well-known bitter flavour, to endow the beer with narcotic properties, and finally to act as a preservative agent and so enhance the keeping qualities of the beer.† After boiling, the worts are rapidly cooled down to a temperature varying from 58° to 62° F., and run into the fermenting "rounds" or "squares." Yeast is now added, or, in the language of the brewer, fermentation is said to be "pitched" at a temperature varying with the locality and the practice and ideas of the brewer.

Fermentation proceeds rapidly, attended by a rise in temperature; and here comes one of the most critical parts of the process of brewing. It is after the worts have arrived at the fermenting tuns that the brewer's skill and experience comes in. I do not mean that any amount of skill in regulating the fermentation will ever remedy carelessness in mashing, because if the wort is not perfectly sound on its arrival at the fermenting tuns a perfect fermentation cannot be obtained; but only that, be they ever so satisfactory at this point, negligence or unskilfulness will be then even more fatal than at any other previous stage. Here it is that, with a climate like that of Sydney, ice or artificial cooling machinery becomes absolutely essential for the production of good beer. Experience has shown that fermentation should never exceed 70° to 72° F. When this temperature is exceeded no amount of after treatment or doctoring of the beer will ever remove its own inherent bad quality.*

What goes on in the act of fermentation will be better understood if we regard the wort merely as a sugar solution with some other albuminous bodies that may be more conveniently considered hereafter.

Alcoholic fermentation is the outcome of the life of a minute plant,—a very lowly organism called the yeast-cell or *Saccharomyces cerevisiæ.* The sugar solution is its arena, and ethylic alcohol is one of the products of its own life-decomposition, just as much as urea is one of the life-products of a man. As plants possess the faculty of changing the carbon dioxide of the atmosphere into starch, sugar, alkaloids, and other products, so this little cryptogam lives upon the maltose of the brewer's wort, changing it into alcohol and other compounds.

The illustrious Pasteur found that 100 parts of cane-sugar, first converted into the fermentable variety of sugar, will yield—

Ethylic alcohol	48·40 per cent.
Carbon dioxide	46·60 ,,
Succinic acid	0·67 ,,
Glycerin	3·30 ,,
Cellulose fat, &c.	1·20 ,,

Now it is just at this critical stage of fermentation that other higher alcohols may be produced. Pasteur, Schützenberger, and Berthelot all recognise the fact of the simultaneous evolution of the higher alcohols under varying or under abnormal conditions. Schützenberger says† :—"We may ask whether these secondary products [*i.e.*, fusel oil], which are relatively not very abundant, owe their origin to alcoholic fermentation properly so called, or to distinct concomitant fermentation having each a special ferment; or whether, in fact, it is better to attribute their appearance to special principles accompanying glucose in the natural saccharine juices. The actual state of science does not allow us as yet to answer these questions definitely.

Pasteur‡ mentions the production of butylic alcohol in irregular fermentation, and its non-appearance in carefully conducted fermentation.

Before proceeding further it will be well to see what is the actual composition of properly brewed genuine beer, so far as it has been investigated by modern chemical research.

Percentage composition of genuine beer:—

Extract	Dextrin	from 2	to 5
	Albumenoids	,, 0·2	,, 0·4
	Maltose..	,, 1	,, 3
	Lactic acid	,, 0·02	,, 0·05
	Succinic acid	,, 0·04	,, 1
	Glycerin	,, 0·2	,, 0·25
	Colouring-matter / Hop extract ..	,, 1	,, 1·2
	Ash (mineral matter) ..	,, 0·2	,, 0·27
	Total extract ..	,, 5	to 8
Alcohol (by weight)		,, 3½	to 7
[Alcohol equivalent in proof spirit		,, 7¾	,, 15¼]
Acetic acid		,, 0·02	,, 0·04
Carbonic acid		,, 0·22	,, 0·25

* Read before the Royal Society of N.S.W., November 2, 1887.

† Hops are to the high fermentation brewer what ice is to the brewer of lager beer.

* Pasteur speaks of this as "a rigorous limit of fermentation temperature." "Etude sur la Biere," Paris, 1876, p. 14.

† "Fermentation." Kegan Paul, Trench, and Co., London, 1883, p. 30.

‡ "Etude sur la Biere." Paris, 1878, p. 297.

The origin of the enquiry which forms the subject-title of this paper arose during the ordinary routine work in the Government laboratory. For several years the examination of beers was somewhat a rare occurrence, but in the year 1881 a Mr. Waters, from Melbourne, created no small excitement by stating that the beers made in Sydney contained vitriol, aloes, bluestone, and infusion of tobacco juice. The result of this alarming statement induced Mr. Barney, Chief Inspector of Distilleries, to send a number of spirituous liquors to my predecessor, Mr. Charles Watt, for analysis. It appears, from the enquiry then made, that the chief interest centred in the quality of the rum, whisky, and brandy; however, later on, in the following year, some eleven samples of Sydney beer were examined.

During the four years from 1882 to the end of 1886 a very large number of samples were examined in the Government laboratory. The general results showed that the statement of Mr. Waters was without foundation. The methods of analysis usually included the estimation of the percentage of alcohol, ash, and extract together, with some statement to the effect that none of the articles mentioned in the Licensing Act had been found. In fine, the worst that could be said of the beers was that sometimes traces of lead or copper were found.

Early in the present year the question of artificial bitters and hop substitutes engaged the attention of analysts in England, amongst whom my friends Dr. Muter and Mr. Otto Hehner were much interested in the subject. At the same time statements were frequently heard in Sydney to the effect that the brewers were in the habit of putting poisonous bitters into the beers instead of hops, and inasmuch as the police were constantly sending samples of beers and spirits for analysis, I wished to seek further satisfaction in the matter by carrying out a fuller and more extended investigation as to the nature of the bitter principle used in the manufacture of the local beer: with this object in view I requested that larger samples should be submitted for analysis. These were all specially examined for strychnine, picric acid, cocculus indicus, and tobacco, as well as for quassia, gentian, chiretta, &c. In the case of all the brewers it should be said, to their credit, that no poisonous bitter of any kind could be discovered, not even after a most laborious and lengthy research.

During the course of analysis it was observed that the proportion of dextrin was unusually large, while the amount of maltose and albumenoids were extremely small. This might, of course, be attributed to great attenuation in the process of fermentation. In the course of mashing with malt the proportion of dextrin to maltose goes on in very nearly a fixed ratio up to 140° F., when the maltose diminishes rapidly and the dextrin increases very considerably. Therefore are we to account for the dextrin by high mashing heats? or would it not more likely be owing to the fact that large quantities of sugar are used in the brewing process? If this be so, why does the brewer use sugar, and, if so, what kind of sugar?

The object of the brewer in using sugar may be considered under two heads: first, his object is to reduce the proportion of the albumenoid matter in the wort; and secondly, to effect a saving in the price of malt,—in other words, to use as little malt as possible, because barley is not grown here and has therefore to be imported, while sugar grows well, as everybody knows.

In the ordinary brewing process the reduction of albumenoids is mainly effected by the boiling of the wort after mashing; but it is also further considerably effected by the tannin of the hops, and by the employment of natural or else artificial waters, containing suitable saline bodies, principally sulphate of lime, which renders some of the albumenoids insoluble.

Notwithstanding these various methods of reducing the albumenoids, it is generally found by most brewers that a further reduction is necessary beyond what is attainable by these means. Now the addition of sugar effects this by the simple process of diluting the albuminous wort with a substance which is non-albuminous, but yet fermentable. These albuminous bodies, from a sanitary or dietetic point of view, would prove of advantage to the beer consumer, inasmuch as these are flesh and tissue formers, being in fact the proteid matter from the grain. The reason why stout would be given to the invalid or the convalescent would be precisely on account of these albumenoids, which are studiously eliminated in the manufacture of Sydney beer. From the brewer's point of view he would say they were decidedly objectionable, since they would prove food for the *yeast-cell*, and for false or adventitious ferments. And still these albumenoids are essential for the healthy growth of the yeast, so that it is important that the brewer has a sufficient quantity in his worts for the yeast to live upon, as otherwise the *S. cerevisiæ* would starve and die. The main object of the brewer is to conduct his fermentation without the introduction of the false ferments, so called,—the lactic, acetic, and butyric ferments. A beer so made, and afterwards kept from their contamination, would keep sound for an indefinite length of time.

Now, as to the why and wherefore of the use of sugar. The beer betrays its origin by its taste; albeit the demand may be for sweet ales, or sweet "running ales" as they are sometimes termed, the sweetness may not be due to cane-sugar; certainly not, since the sugar has undergone a change. If sugar crystals are used in brewing Sydney beer, and there is internal evidence from the beer itself that such is the case, the brewer must first convert them into a fermentable variety of sugar; the sugar must be inverted, as it is more correctly termed. Cane-sugar of itself is unfermentable. This inversion may be effected in four different ways:—

1. By malt extract in mashing at not too high a temperature.
2. By prolonged boiling with water.
3. By treatment with yeast and water.
4. By the action of sulphuric acid and after treatment with chalk.

The brewer is confronted with the question as to what sugar may be used, raw or refined crystals? If the former, other organisms besides the *S. cerevisiæ* would inevitably be introduced: this would be followed by a high and uncontrollable fermentation; with refined crystals the sugar, we have seen, has to be inverted. Another question then arose, Were these beers brewed at an abnormally high temperature? Remembering that an eminent authority on brewing, Dr. Charles Graham, had found that a high temperature in fermentation means not only a rapid attenuation of the wort, but an increased loss of alcohol by evaporation, together with an increase in the higher alcohols—the fusel oils; reasoning upon this hypothesis the presence of fusel oil would therefore indicate to some extent the mode of manufacture of the beer. The question then resolved itself into this—Does this beer contain fusel oil? Some difficulty then arose as to the process for finding out whether higher alcohols existed in beer. The methods in use which were applicable to liquids such as brandy and whisky failed when applied to beer. The method of fractional distillation was tried: the distillates from two litres of beer were placed in a flask fitted with a modified Hempel's column and the fractions collected separately, a current of steam being used to remove the last traces. As the boiling-points of the different alcohols were not sufficiently marked from each other, the idea presented itself of converting the alcohols into their respective iodides, since the boiling-points would be sufficiently removed from each other to enable a more complete separation to be effected.

However, these methods were afterwards abandoned, since it might be said that these higher alcohols might be generated in the act of distillation, an objection that I do not think carries much weight, as the alcohols are

products of fermentation and are not likely to suffer changes in distillation. However, these methods were set aside for a process that would remove the higher alcohols from the beer itself, *without* distillation. The process I finally adopted—a modification of my own of Marquardt's—was based upon the fact that amylic alcohol is soluble in chloroform. I operated on a gallon of the beer in the following manner:—Some of the beer to be tested is placed in a capacious separator, together with 50 c.c. of chloroform: after repeated shaking, the liquid is allowed to subside, and the beer poured off without disturbing the chloroform. More beer is added until half the gallon has been so treated, when a further 50 c.c. of chloroform is added, together with more of the beer, until about 5 pints have been used; a third 50 c.c. is taken, making altogether 150 c.c. of chloroform with which the remainder of the beer is thoroughly agitated. By this time the whole of the fusel oil will have been extracted. The next step is to wash the chloroform with water to remove traces of valerol derivable from the hops, and also to remove ethylic alcohol that may have been taken up into solution. The solution is then placed in a strong glass vessel with 5 grms. of potassium dichromate and 2 grms. of concentrated sulphuric acid, and oxidised under pressure for six hours at a temperature of 85° C. The oxidation having been completed, the liquid is now distilled, water added to the residue, and the distillation continued. The distillate, which has a strong odour of valerianic acid, is boiled for half an hour with some pure barium carbonate in a flask connected with an inverted Liebig condenser. After this the chloroform is removed by distillation, and the residue filtered. The filtrate is then evaporated to dryness in a platinum dish, weighed, and dissolved in water with a few drops of nitric acid. The solution is divided into two equal parts. In one the barium is estimated; in the other the amount of barium chloride. The weight of the latter is deducted from the residue, The total amount of barium salt, minus that existing as chloride, gives the amount of barium as barium valerianate, and from which the amount of amylic alcohol is readily found.

The chloroform and the rectified spirit used throughout this research was carefully tested by blank experiments for the presence of the higher alcohols. Care was taken that only pure chloroform was used.

(To be continued).

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of emperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 5, July 30, 1888.

The Relations of Atmospheric Nitrogen to Vegetable Soil.—Th. Schlœsing.—In the varied and prolonged experiments of the author the soils examined have not fixed any gaseous nitrogen.

The Determination of Carbon and Nitrogen in Vegetable Soil.—Th. Schlœsing.—The author mentions that in lands manured with street-sweepings the amount of carbon is greatly exaggerated in consequence of fragments of coke, coal, &c., thus introduced. The author partially avoids this error as follows:—200 grms. of the sifted soil are spread out in a muffle, the temperature of which scarcely reaches incipient redness. The organic matters are very combustible, and disappear totally. Coke remains, and may be afterwards determined separately. Wood-charcoal burns with the organic matters. In determining the nitrogen M. Schlœsing uses from 150 to 250 grms. in order to secure a fair average specimen. He uses combustion tubes of 2 metres in length; his gas furnace is 1·85 metres long, and has 88 Bunsen burners. The tube receives the ordinary charges of roasted copper-turnings, extending to 0·60 metre, this portion being wrapped in a ribbon of tinsel. Then follows, between two asbestos plugs, a small tube stoppered at one end, and containing 10 grms. pure lead carbonate. The soil occupies all the rest except 0·15 metre at the end left empty. The tube is laid above the burners on a bed of sand in a channel of brass. This channel is cut in three sections, the first under the copper turnings, the second, much shorter, under the lead carbonate, and the third under the earth. The drawn-out end is connected with a two-necked receiver in which is condensed the water given off in the operation; the receiver is also connected with the leaden capillary tube of a mercury-pump. To the other extremity of the tube is connected a green glass retort containing pure potassium chlorate.

The Density of Chlorine and the Vapour-density of Ferric Chloride.—C. Friedel and J. M. Crafts.—At elevated temperatures the authors find the density of chlorine 2·448, which approaches very closely to the theoretical value, 2·449. Between 321° and 442° ferric perchloride has a fairly constant density, corresponding to the formula Fe_2Cl_6.

The Vapour-density of Gallium Perchloride.—C. Friedel and J. M. Crafts.—The authors' mean result is 12·36, theory requiring 12·2 for the formula Ga_2Cl_6. Above 307° there is a notable decrease of density, the value at 357° being 8·5 and at 440° 6·6.

In What Stages of Oxidation do Chrome and Manganese Exist in their Fluorescent Compounds?—Lecoq de Boisbaudran.—This question does not receive any definite answer.

Determination of Lithium in Mineral Waters. Analysis of Two Springs in the Côte d'Or.—A. Carnot.—A known volume of water is concentrated by evaporation, eliminating successively the alkaline-earthy carbonates, iron oxide, silica, sulphuric acid, magnesia, baryta, lime, and lastly the ammoniacal salts, always ascertaining that none of the deposits contain lithia. There remain in solution merely alkaline chlorides, perhaps accompanied by traces of magnesium chloride. This solution is gently evaporated until the salts begin to deposit, when it is constantly stirred with a platinum spatula, so as to have a fine crystalline powder. We stop before dryness and mix with alcohol at 99 per cent, grinding with a pestle and letting digest for some time, then filtering and draining with the filter-pump. A large part of the chlorides are thus removed, and we find, with the spectroscope, that they do not contain lithium. The alcohol is distilled off, the saline residue left is dissolved in a little water with two or three drops of hydrochloric acid, evaporated, and treated while still moist with strong alcohol. It is received on a filter, drained, and washed at first with alcohol alone, and then with the addition of ether, which dissolves out the last portions of lithium chloride. The ethereal alcohol is distilled off, leaving with the lithium chloride merely a small proportion of other alkaline chlorides. To this residue is applied the method described in *Comptes Rendus*, vol. cvii., No. 5.

Economical Production of the Chlorides of Oxidised Elements, such as Aluminium.—A. Faure.—The author uses hydrochloric acid instead of chlorine, and does not mix with carbon but with naphthaline.

Process for Separating and Determining Zinc.—J. Riban.—This paper will be inserted in full.

On Sodium-glycol-alcoholate.—M. de Forcrand.—A thermo-chemical paper, not capable of useful abstraction.

A Dibenzoic Ether derived from Mannite.—J. Meunier.—This ether has the composition $C_{20}H_{22}O_6$.

Zeitschrift fur Analytische Chemie.
Vol. xxvii., Part 1.

Researches on the Equations of Indirect Analyses.—S. Panpuschko.—This paper does not admit of useful abstraction.

Safety-Pinchcock.—N. von Klobulow.—This paper requires the five accompanying figures.

Apparatus for Extracting Fats in the Cold.—This paper requires its two figures.

Determination of the Quantities of Lime and Soda required for Softening Water.—Otto Binder.—To 200 c.c. water placed in a 300 c.c. flask are added 50 to 75 c.c. of saturated lime-water containing a known proportion of lime. This is determined with a sulphuric acid containing, per litre, 1·857 grms. sulphuric acid; 1 c.c. of this acid represents about 1 c.c. of lime-water, and is prepared by diluting 46·43 c.c. normal acid to 1 litre. The sample, mixed with lime-water, is heated (the mouth of the flask being loosely stoppered with a perforated cork holding a thermometer) to the temperature designed for the softening of the water on the large scale; therefore to 50° to 80° (?) When the contents are cold the flask is filled to the mark with distilled water free from carbon dioxide, and 250 c.c. are filtered through a dry folded filter. In the filtrate the excess of caustic lime is titrated back, the quantity used for 1 litre being found by calculation. In most cases a considerably larger quantity of lime is required than that which corresponds to the temporary hardness. *Determination of the Soda to be Added.*—For this purpose 250 to 300 c.c. of water is evaporated in a platinum dish to dryness with 5 c.c. of a normal soda solution. The residue is dissolved in water, filtered, washed, the undecomposed sodium carbonate is determined volumetrically with acid and methyl orange. The difference shows the proportion of soda needed for the decomposition of the chloride, sulphates, and nitrates. About 10 grms. soda per cubic metre should be used over and above the quantity thus determined.

Overflow-point for Burettes.—Otto Binder.—This paper requires the three accompanying figures.

Funnel Support for Drying Precipitates in the Funnel.—The writer proposes to make the horizontal rods of Meurer's funnel-support curvilinear instead of straight.

Determination of Traces of Arsenic in Tissues, Yarns, and Paper-hangings.—R. Fresenius and E. Hintz.—This paper will be inserted in full.

Quantitative Determination of Acetone in Methylated Spirits, in Methylic Alcohol, and (Commercial) Acetone.—E. Hintz.—The quantity of acetone, from 0·2 to 0·3 per cent, occurring in commercial methylated spirits, as supplied to colour-works, can be well and accurately determined according to G. Krämer's method (*Berichte*, xiii., p. 1000) by converting the acetone into iodoform and weighing the latter. In accurate determinations it is well to make a blank experiment with the reagents in the absence of the methylated spirit, and, in afterwards calculating the acetone, to deduct the small quantity of iodoform and iodides thus obtained. Such a blank experiment yields about 0·002 grm. Krämer's method is satisfactory for samples containing 5 per cent of acetone, but for smaller proportions it is not trustworthy. It is therefore advisable to dilute any sample with water, so that its proportion of acetone may be from 1 to 1·5 per cent.

Detection of Nitric Acid in Wines.—Eugene Borgmann.—The author has examined Egger's method, which consists of treatment of the sample with diphenylamine and strong sulphuric acid. This reaction is most sensitive if a freshly prepared solution is used of 0·01 grm. diphenylamine in 100 c.c. pure monohydrated sulphuric acid. The wine must be previously decolourised by means of animal charcoal, which, as well as the other reagents, must be absolutely free from nitric acid. Nitric acid, if present in small quantities, disappears in course of time.

On Thermometers and Thermometric Determinations.—A collection of extracts from the *Zeitschrift fur Instrumentenkunde*, the *Philosophical Magazine*, the *Journal of the Society of Chemical Industry*, and the *American Chemical Journal.*

The Determination of Vapour-densities.—This memoir requires the two accompanying illustrations.

Gas-tight Glass Cocks.—A. Eiloart.—From the Chemical News.

Gas-absorption and Measuring Apparatus.—W. H. Greene.—From the *American Chemical Journal.*

A Modified Mercurial Air-pump.—A. Joannis.—The peculiarity of this apparatus is that instead of a vessel being alternately raised and lowered, both vessels are fixed and are connected by a U-tube. The advantage of this new construction is that the thick caoutchouc tube, necessary in all other models, is dispensed with, and that the movement of the mercury is gradual, thus obviating the danger of breaking the cocks.

Apparatus for Distilling Mercury.—B. Nebel.—This memoir requires the accompanying figure.

Quantitative Determination of Zinc.—Max Bragard.—The author particularly examines precipitation in a formic solution, especially for its separation of other metals from the ammonium sulphide group. In thus separating zinc from nickel the solution must be sufficiently acid to prevent the precipitation of nickel by sulphuretted hydrogen, the addition required being 5 c.c. formic acid (sp. gr. 1·1136) to 0·03 grm. nickel. The free acid must not exceed a certain limit if the zinc is to be thoroughly precipitated. But if increased acid is required by a large quantity of nickel the solution must be diluted to 500 to 600 c.c. If the precipitation is to be effected in heat more acid is required than for a cold solution. If the zinc sulphide is contaminated with nickel sulphide the precipitate is re-dissolved in hydrochloric acid, the sulphuretted hydrogen expelled, ammonia and formic acid are added, and a fresh current of sulphuretted hydrogen is passed through the liquid. Zinc can be separated in the same manner from iron, more free formic acid being used and the volume of the liquid increased. The precipitation of zinc in a citric solution presents no advantage, the precipitate being exceedingly difficult to filter and to wash. Bragard has further examined Tamm's determination of zinc as ammonio-phosphate (Chemical News, xxiv., 148). He finds this method most successful if 0·2 to 0·4 zinc is contained in 400 c.c. solution, and if the precipitate is allowed to stand for twenty-four hours. To prevent the precipitate from running through the washing-water should have at first the same temperature as the filtrate, and should be made hotter by degrees. He endeavoured to weigh the precipitate as pyrophosphate. He finds that a volatilisation of zinc may be avoided if the precipitate is heated alone, at first with a small flame, gradually made stronger so as to exclude the reducing action of the flame gases. Very strong heating should be avoided. To prevent the reductive action of the carbon from the filter, the precipitate is filtered in the smallest possible filter, from which it is carefully separated when dry. The paper is then carefully burnt separately after being moistened with ammonium nitrate. Zinc may be separated from magnesia by precipitation with sodium phosphate and excess of ammonia, provided the quantity of magnesia is not too large. Manganese can be separated in this manner from zinc only if in small proportion.—(*Chem. Zeitung*).

Determination of Cadmium and its Separation from Copper.—A. Kœhner.—This paper will be inserted at some length.

A Characteristic Reaction of Secondary Alcohols.—G. Chancel.—Already noticed under *Comptes Rendus.*

Volumetric Determination of Phosphoric Acid by Means of Uranium Nitrate.—Charles Malot.—Uranium nitrate forms a lake with the colouring-matter of cochineal; the author uses this result to indicate the end of the reaction in determining phosphoric acid. When the preliminary operations have been carried so far that the ammonium-magnesium phosphate exists dissolved in dilute nitric acid, some drops of an aqueous solution of cochineal are added, and then so much dilute ammonia that the colour appears just violet. This colour is then again removed by one or two drops of nitric acid. The liquid is now heated to 100° and mixed with 5 c.c. of a solution of sodium acetate, and the solution of uranium nitrate is then dropped in with a burette. Each, drop, on falling, produces a greenish blue colour, which disappears again on stirring, until the last drop turns the whole mass of the fluid a permanent green. No uranium can then be detected in the solution. The reaction is, therefore, very distinct, and permits of the determination of phosphoric acid in great dilution.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Molybdic Acid.—I should be very much obliged if any reader of the CHEMICAL NEWS could give me any details of the manufacture of molybdic acid and molybdates commercially.—H. B. STOCKS, 58, Nuttall Street, Liverpool.

ERRATUM.—P. 63, col. 2, line 16 from bottom, *for* "not only of this but any method in which the sulphur," *read* "not only of this but any method, the one in which the sulphur."

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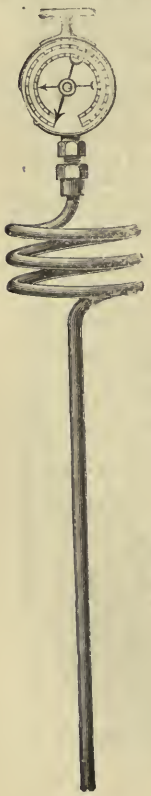

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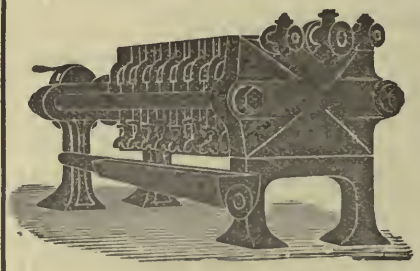

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1500.

CURIOUS ASSOCIATION OF HYDROCARBONS WITH ROCK-SALT IN NATURE.

By F. MAXWELL LYTE, F.C.S.

The requent association of salt and bitumen or petroleum in the same deposits has often struck me as likely to lead to the development of some probable theory as to the formation of these hydrocarbons. Almost all specimens of rock-salt, when struck or rubbed, give off more or less the characteristic odour of bitumen. Beds of rock-salt are often coloured brown by the bitumen they contain, and petroleum, on its emergence, is nearly always associated with brine. Deposits of rock-salt are, as a rule, dry and anhydrous, though salt itself has a considerable attraction for moisture. But more than this, those salts of potassium and magnesium often occurring with it are still more greedy of water.

If the seemingly probable theory that all formations of rock-salt are due to the evaporation of sea-water be correct, then these deliquescent and hygrometric chlorides would almost always have beeen the last part deposited in every bed of rock-salt, and though, owing to their great solubility, they may have been denuded and washed or melted away perhaps long afterwards, it is probable that they generally formed the final layer at first. These would, by their affinity for water, both during their formation and subsequently, tend to withdraw that liquid from all surrounding substances.

Now most organic matter may be looked upon as a hydrocarbon combined with the elements of water. Withdraw the water and the hydrocarbon remains. Metallic iron, if present, might modify the reaction. Is it not, then, a probable theory that most natural deposits of hydrocarbons owe their origin to this absorption of water, acting through the lapse of ages on organic matter, often aided by heat and pressure? If such be admitted it would account for the frequent association of salt with hydrocarbons.

DISSOCIATION IN FUSED METALLIC SULPHIDES.

By T. STERRY HUNT.

In a note in the Chemical News, vol. lv., p. 3, Mr. T. Moore has described the formation, in a nickel matte or regulus, during its slow cooling, of brilliant crystalline plates, malleable and ductile, of metallic nickel, alloyed in different samples with from 12 to 28 per cent of iron, and amounting, in some cases, to one-tenth of the mass. A regulus containing Ni 73·8, Fe 4·2, S 22·0, in which the ratio S : M = 1 : 1·9; after yielding a portion of an alloy of Ni 86·4, Fe 13·6 gave the ratio 1 : 1·6 nearly, as calculated from Moore's analyses.

This process is not without precedent, since I published, in 1873, with details, the evidence of the separation of metallic iron from a copper-iron matte, with the further fact that the fused mixture was an oxysulphide, and was dissociated, on cooling, into an aggregate of metallic iron, magnetite, and sulphides. In commenting upon this fact in the second edition of my "New Basis for Chemistry" (Boston, 1888), p. 164, it is noted that the separation of filamentous copper (the so-called moss copper) during the cooling of rich copper regulus, is evidence of a similar dissociation of a sulphide, instable save at high temperatures. I transcribe the foot-note given on the page just cited.

"A matte got from the first fusion of a roasted cupriferous pyrites held 45 per cent of copper, with a little zinc, and was strongly magnetic. Oxidised by nitric acid or by bromine, it left more than 10 per cent of pure magnetic oxide of iron. It, moreover, precipitated metallic copper and lead freely from solutions of these metals, and gave up to dilute acids the larger part of its iron, with evolution of free hydrogen and hydrogen sulphide gases, the latter apparently formed by the action of nascent hydrogen upon the metallic sulphide; from all which facts it was regarded as an intimate mixture of metallic iron, magnetite, and sulphides."—(*Trans. Amer. Assoc. Adv. Science*, 1873, p. 143).

Mention should here be made of the remarkable subsulphide found crystallised in cavities in the hearth in smelting for nickel matte in Pennsylvania, lately described by J. B. Mackintosh (*Trans. American Institute of Mining Engineers*, 1887). He found for brilliant cubical crystals the ratio S : M = 1 : 6, and the formula Fe_4Ni_2S; two previous analyses of another specimen by Voigt having given similar results. It may be said that the sulphurous cast-irons offer us still more basic compounds of iron with sulphur.

London, August 10, 1888.

ON THE PRESENCE OF FUSEL OIL IN BEER.*

By WILLIAM M. HAMLET, F.C.S., Government Analyst.

(Concluded from p. 83).

Another method for the estimation of minute quantities of amylic alcohol, and indeed for all the higher alcohols, is that of Traube,† who employs a method based on the fact that butylic and amylic alcohols depress the capillarimetric column in a small tube. This process has in my hands been found more suitable for brandies and white spirits than for beer.

During the first experiments in working out this process, a somewhat unlooked for result was obtained; one giving positive indications that genuine hops had been used in the brewing of all the samples of Sydney beer; thus corroborating the results I obtained by the methods of Dupré and Allen used in my search for spurious bitters and hop-substitutes.

Hops contain about 7½ parts in a thousand of an essential oil. This oil consists of a terpene isomeric with turpentine oil ($C_{10}H_{16}$) and a stearoptene termed valerol ($C_6H_{10}O$?): the first, being a very volatile etherial body, is entirely dissipated during the process of brewing, and gives that pleasant aromatic odour often noticed in the brewery; the second consists of a mixture of the stearoptene valerol and resin. The valerol is easily oxidised by ordinary atmospheric oxidation into valeric acid, which may sometimes be observed in the peculiar cheesy smell of old hops.

Valerol being soluble in ether and in ethylic alcohol would therefore be found in the crude chloroform extract; hence the necessity for a prolonged washing with water to remove both the valerol as well as the ethylic alcohol before proceeding further with the process. If the impure and unwashed chloroform be oxidised the valerol would become oxidised into valeric acid along with the amylic alcohol. The presence of the hop oil of the hops may therefore be recognised if the chloroform residue be divided into two parts; one of which is thoroughly washed and oxidised by chromate. If oxidation yields valeric acid in the one case and none in the other, then it follows, and I think proves conclusively, that hops have been used in brewing the beer.

* Read before the Royal Society of N.S.W., November 2, 1887.
† *Bulletin de la Societé chimique de Paris.*

The process, therefore has a double value and significance; namely, in determining first, whether the beer has been really flavoured with hops, and secondly, if the higher alcohols are present.

To remove all doubt as to whether the fusel oil really existed in beer, I took two litres of beer and removed the whole of the ethylic alcohol by slow and careful evaporation; the liquid was made alkaline by sodium hydroxide treated with ether in a separator and the valerol thus removed. Acetic acid was then added to neutralise the soda and the chloroform process, as before described and carried out. The result was that barium valerianate was produced as before. This was dissolved in water with a few drops of nitric acid, the barium estimated as sulphate, and the amount of fusel oil found and expressed in terms of amylic alcohol.

Four and a half litres of beer (=1 gallon) gave 0·530 grain of barium sulphate, equal to 0·4 grain of amylic alcohol per gallon.

One gallon of another sample gave on analysis 0·324 grain of barium sulphate, equal to 0·245 grain of amylic alcohol per gallon.

In another instance one gallon of a beer gave 1·18 grain of barium sulphate, equal to 0·89 grain of amylic alcohol per gallon, this being the largest proportion found. The amount therefore of fusel oil ranged from ¼ grain to nearly 1 grain [0·245 to 0·89] per gallon.

Molecular weight of $C_5H_{11}HO$ = 88
ditto $C_5H_9O_2H$ = 102
Molecular weight of $(C_5H_9O_2)^2Ba+2OH_2$ = 375
1 part of ditto = $0{\cdot}544 C_5H_{11}HO$
1 part of $BaSO_3$ = $0{\cdot}7553\ C_5H_{11}HO$

In the case of Marquardt's process for brandies and whiskies:—

1 part of $(C_5H_9O_2)^2$ Ba contains 0·4513 BaO;
Whereas—
1 part of $(C_2H_5O)_2$ Ba contains 0·674 BaO.

Fusel oil or fousel oil, Fr. *Huile de pommes de terre*, Ger. *fuselöl*, derived from the Greek φιω, I produce, alluding to its *production* or generation in and during the act of distillation and not merely to its *eduction* or mere separa- from a liquid in which it is already present. I may say that I have very strong grounds for saying that it is not so, and that fusel oil is not a mere creature of the distilling process; but that it existed in the wash before distillation took place. However that may be, I will give a short description of what fusel oil is, and would refer my hearers to the many published accounts of this liquid.

The compound known as fusel oil is a complex oily liquid possessing a powerful sickly odour, producing nausea, coughing, irritation, and headache when inhaled, and having a biting fiery taste. It occurs in the residues, the faints,* of the distillation or rectification of all kinds of spirit, such as cane spirit, brandy, potato, rye, maize, and other grain spirit, from the marc of grapes and from the fermentation of sugar and glucose.

I desire it to be stated that I am not the first discoverer of fusel oil in beer, and that a paper appeared in the *Comptes Rendus*, xcvi., [19] 1368—1370, by J. A. Le Bel, who shows that amylic alcohol† is a product of the fermentation of beer. It has also been shown in Germany that when impure saccharum was used in brewing, that fusel oil was developed. in the *Rep. Anal. Chem.*, v., 188, a case is cited where a brewer was fined for allowing fusel oil to appear in his beer, and where it is stated that the fusel oil "may under certain circumstances prove injurious to health."

Toxic Action of Fusel Oil.

The administration of a quantity estimated at not more than ½ grain kills frogs. One minim sufficed to kill three blow-flies. One minim killed a minnow. Two minims was fatal to guinea pigs. Sixty grains of fusel oil was given to a dog. The effect was instantaneous, producing muscular paralysis of the hinder legs, with drunkenness, giddiness, and stupor. In a few minutes the animal was quite unable to stand on its legs and rolled about on the floor. In ten minutes the muscular tremors came on, recurring with perfect regularity. In twenty minutes there was foaming at the mouth. In thirty minutes the muscular tremors came on in paroxysms, especially at each inspiration of the lungs, amounting to what Dr. Ashburton Thompson better described as a spasm. The tremors continued for some time. In three hours the dog was in a state of coma, the twitching going on all the while regularly. At this stage violent headache and nausea was experienced by myself and two other observers. The dog was seized with a most violent fit of vomiting about five hours after, and partially recovered in 24 hours from the time of administration.

In conclusion, these results may be summarised as follows:—

1. That traces of certain other alcohols besides ordinary ethylic alcohol exist in most of the beers brewed in Sydney.

2. That these may be derived either from the temperature at which the fermentation is allowed to take place; or from the excessive use of saccharum, glucose, or sugar crystals, or from both.

3. That the presence of even traces of fusel oil is quite undesirable and most probably injurious to health, since it is known that small quantities of fusel oil act as a poison on the animal system.

Discussion.

Mr. W. A. Dixon, F.C.S., said that it seemed to him that too much attention had of late been given to minute analysis of foods. Since Mr. Hamlet's first report had been published he had given a good deal of attention to this matter and had himself carried out some experiments. From these, as far as he had gone, he concluded that the glycerin formed during fermentation was extracted by the chloroform, and in the process used by Mr. Hamlet this was oxidised to formic acid and determined as valerianic acid and hence as amylic alcohol. Mr. Hamlet appeared to have only examined beers manufactured in Sydney. He (Mr. Dixon) had examined beer brewed at home, and found as much amylic alcohol as in any beer brewed here. It seemed to him that amylic alcohol was always produced more or less in fermentation; and that its production was not well understood. It is only known that it is produced in largest quantity from roots, next from raw grain, and generally when the yeast was in bad condition, and the temperature high. He did not think the temperature of fermentation here was carried much higher than at home, not much beyond 76 or 78° F., at the outside. If much amylic alcohol was produced the beer would be very distasteful. What was essential at one time was not so at another; thus, at one time beer was brewed without hops at all; in the reign of Queen Elizabeth very stringent regulations were laid down against the use of hops in beer, but the use of hops has so grown that the use of beer without is now almost unknown. Beer was a complex liquid containing various ingredients which made it palatable; some of them affected the sense of taste and others the sense of smell; these were called sapors and odours, and together flavour. The bitter of hops and the salt affected the taste; some people liked more of the latter, some less, but the quantity present could scarcely produce thirst. The ingredients which affected the organs of smell were the oil of hops and the small quantities of those higher alcohols which were present, and if these were left out the beer would be undrinkable. What Mr. Hamlet has said with regard to the water here being particularly soft, and therefore taking up a large quantity of albuminous matter, was perfectly correct, and the brewer got rid of that difficulty by the use of sugar, as otherwise the beer would never be bright. The waters used in the brewing of some of the

* Faints contain over 60 per cent amylic alcohol.
† Named amylic alcohol by Cahours, from *amylum* starch.

English beers contained, besides the sulphate of calcium mentioned, sulphate of potassium, and both these were absent in Sydney waters. British beers contained from 200 to 300 grains of inorganic matter per gallon, which was more than in Sydney beer. With regard to the intoxicating effects of amylic alcohol, he did not think much dependence would be placed upon experiments made on animals. The effect of experiments made on different men might be very different, and the difference might be still greater between experiments made upon a man and a dog. For example, give a glass of rum to a black-fellow and he would be hopelessly drunk, but on most white men it would have no effect one way or the other. Various people had given different accounts of the effects of amylic alcohol; some said that it was fifteen times as intoxicating as ordinary alcohol; others said three grains produced decided effects. He knew of a case in which a man took a jar of fusel oil, thinking it was brandy, and took a mouthful of it; it made him drunk, but he soon got over it. Even if beer contained one grain of fusel oil per gallon, he did not think that was sufficient to condemn it, but he had not found nearly as much. As a chemist, he thought that too much importance was often attached to minute chemical analysis, and in a general way he considered that what would pass his sense of taste and smell was good enough.

The Rev. S. Wilkinson said he had been enabled to make some observations of the evil effects of fusel oil. There was one part of this colony in which wine was very extensively produced, and to his certain knowledge considerable quantities of very coarse sugar was used in fermentation in order to to produce the wine; that he knew to be a fact, and it was a certainty from that fact that a considerable quantity of fusel oil is generated by fermentation to produce the wine he alluded to. But what was the result of it? He had been talking to a very trustworthy man in the police of that district, who had large experience of the men who had got drunk upon that wine, and his answer was, "Sir, they are not drunk, they are mad." He observed the difference between the men who got drunk on spirits and those who got drunk on the wine produced largely by the use of sugar, and these latter became perfectly mad with it. He was fully persuaded in his own mind that the larger the quantity of fusel oil found in beer or elsewhere the more deleterious were the effects, and therefore he thought that the results arrived at by our Government Analyst, after skilful examination, were most important, and showed that this oil was to be avoided by every possible means. He had not drunk any beer for a quarter of a century, but had observed the effects upon others. He was very pleased that Mr. Hamlet had not discovered any of those deleterious ingredients that are put in some of the beers in other countries, such as grains of paradise, *Cocculus indicus*, copperas, and other baneful metallic substances.

Mr. Smith said the point seemed to have been lost sight of as to the amount of amylic alcohol necessary to produce any toxic effects. The authorities of the present day give 0·3 of a grain as the quantity required to produce toxic effects on the human system. Mr. Hamlet had shown that colonial beer contained, on an average, 0·05 grain to the gallon; therefore, to get enough amylic alcohol to produce any poisonous symptoms, a man must drink six gallons before it would produce any effect. It had been suggested that it might remain in the system over a period of time, and eventually the amylic alcohol produced toxic effects upon the system. Delirium tremens had been attributed to fusel oil, but was in no way caused by it. Mr. Dixon had spoken about the analysis of foods, and had rather cried down the analysing of food substances. With all due deference to Mr. Dixon he thought the paper read that night proved that there was a use in analysing food substances. Again, Mr. Dixon had made the remark that anything which would pass his nose and palate he thought good enough to take. He (Mr. Smith), while in England studying chemistry, on one occasion had been appointed to go over one of the works where potted meats were largely manufactured. The course of inquiry was with reference to poisonous salts found in the meat, and this necessitated going through the whole process, and during the examination of the manufactory he certainly saw some things which had entirely prevented him, for some years past, from eating potted meats. The filthy way in which the meats were prepared would prevent many of the members here present from eating them again; it was only by analysis that we could find out and put a stop to unhealthy products being put on the market. Again, from a medical point of view, there were many diseases which could not be found out either by nose or palate; there are various species of tape-worm that cannot be found out by chemistry, but they can by microscopical examination.

Mr. W. A. Dixon wished to refer to the incident mentioned by Mr. Wilkinson, where men had been reported to be mad by the policeman as the result of drinking certain wine. He (Mr. Dixon) wished to point out that the effect of fusel oil in those cases in which it had been administered had been to produce coma and not madness. A man would be reported dead drunk, but would not be reported mad by the average policeman if the effect were due to fusel oil. As for potted meats, they never passed his palate.

The Chairman said he was perfectly aware that many ingredients were put in foods, although with no intent to cause injury; he was very glad to find that the samples of beer examined by Mr. Hamlet did not contain those injurious things which had been alleged. He certainly thought, from what he knew of the brewers here, they would not put in deleterious things; he felt assured that it was not the brewers, but the people through whose hands it passed afterwards, who adulterated the beer. Chemical analysis was very valuable, and Mr. Hamlet's investigations proved that fusel oil was there, although not in large quantities; but can it be produced without fusel oil? (Mr. Hamlet: Yes, it can). He was very pleased, and had been instructed by what he had heard that night, and wished that more of their members would come forward with papers. Before sitting down he would mention a fact that just occurred to his mind through reference to hops, and it was this:—That nearly all plants twine from right to left, but the hop is an exception; it twines the reverse way, and it was the only plant he knew that did so. He would tender, on behalf of the Society, a cordial vote of thanks to Mr. Hamlet for his paper.

Mr. Hamlet, in acknowledging the vote of thanks, said that he considered that anyone who had an interest in the State as a citizen should do all he could to investigate such matters rightly. He did not bring forward his paper to "rob a poor man of his beer," as the popular saying goes, but he simply stated what he found to be the fact—that fusel oil was contained in beer. He concurred very much in what Mr. Dixon had stated about the residues in British beers being higher than that in Sydney beer. He did not think that adding salt had any great deleterious effect, nor did he think the amount of common salt that Mr. Dixon referred to had any great effect, having regard to the fact that most people took a considerable quantity of salt in twenty-four hours. It had been remarked that a man must take a large quantity of beer before the fusel oil takes any effect. That might be so, but it was not so much that as the cumulative effect of amylic alcohol. If he were going to be dosed with minute doses for six months, it would accumulate in his system much in the same way as small doses of lead. If you took small doses of lead it would not produce any immediate effect; but, not being eliminated, it would be stored up in the body, and by-and-bye produce very alarming results, and it was quite possible that the toxic action of fusel oil would act much in the same way. The men about the streets were not to be compared with the ordinary drinker, who takes an occasional glass; those poor creatures that we saw standing about the corners of the streets were imbibing it

all day. They are members of the State, and we had, it was to be hoped, some degree of interest in mankind, so as to enable them to get as pure an article as possible. Mr. Dixon had suggested that he should have tried experiments on men and not on animals; that had been a great difficulty with him. He should like very much to have experimented on human subjects, and he had hinted as much, but of course it was an impossibility. He only knew, from these effects upon himself, that it was a very irritating disagreeable noxious liquid. With regard to the incident mentioned by Mr. Dixon of the man who took a gulp of fusel oil, he could only think it must have been largely diluted. The latest authorities on the subject considered that 1-60th to 1-15th of a grain produced intoxicating results. The effect on animals was very distressing to see.

In reply to a question of Dr. Leibius, Mr. Hamlet said there were no recorded experiments of the cumulative effects of fusel oil, but it was inferred from the innate properties of fusel oil that it was so. Of course, he did not compare it with lead, but merely mentioned lead by way of illustration, and it would not be fair to compare it with lead.—*Journal and Proceedings of the Royal Society of New South Wales*, Vol. xxi., Part 3.

A PROCESS FOR SEPARATING AND DETERMINING ZINC.

By J. RIBAN.

The accurate determination of zinc in the moist way presents, as it is well known, great difficulties. The precipitation by means of ammonium hydrosulphate requires a settlement of from twelve to twenty-four hours; the filtration is discouragingly tedious, and we are compelled to load the mother-liquid and the washing waters with ammoniacal salts to prevent the precipitate from passing through the filter.

If we effect the precipitation in an acetic solution by means of sulphuretted hydrogen the sulphide obtained is still gelatinous, and presents similar inconveniences, though in a less degree. The precipitation of zinc by means of sodium carbonate is often incomplete, and the flocculent precipitate carries down considerable quantities of alkali, which cannot be completely eliminated by washing. Moreover, this method cannot be applied in presence of the alkaline-earthy bases, and only permits the separation of zinc from the alkalies.

The author has arrived at a process which is free from these defects. It consists in transforming the zinc salt into a soluble hyposulphate by the addition of an alkaline or earthy hyposulphate and treating it *in the cold* with sulphuretted hydrogen. There is formed a pure amorphous zinc sulphide, so dense that it soon collects at the bottom of the liquid, whilst the supernatant liquid remains clear, notwithstanding the movement produced by the gaseous current. As this precipitate is formed dithionic acid is set free, but its action upon zinc sulphide is very slight, and even null in dilute solutions, so that at certain degrees of dilution the process is at once expeditious and very accurate. The precipitate may be separated from the supernatant liquid by simple decantation, and can then be easily washed by continued decantation and filtration. The liquid containing the salt of zinc is saturated with sodium carbonate until a permanent precipitate appears, and is then re-dissolved by a few drops of dilute hydrochloric acid. To this slightly acid liquid there is added an excess of sodium or barium hyposulphate, more than sufficient to effect the double decomposition with the salt of zinc and the free acid; an excess of the hyposulphate does no harm. The liquid is diluted with water so that it may contain, at most, 0·1 grm. zinc in 100 c.c. There is then passed into it a current of sulphuretted hydrogen in the cold. The precipitate of zinc sulphide, quite white and very heavy, collects quickly. After letting settle for a few minutes the limpid liquid is decanted carefully through a filter. Upon the precipitate is poured boiling water and sulphuretted hydrogen water, when the precipitate soon settles again. After two or three such washings by a decantation through a filter the washing is completed in the filter, always with hot water mixed with sulphuretted hydrogen water. It is dried at 100°, separated as completely as possible from the filter, which is incinerated in a porcelain crucible, after moistening the paper with ammonium nitrate. Lastly there is added to the ash the zinc sulphide and free sulphur, and the whole is ignited in a current of hydrogen according to Rose's process. Or the sulphide may be converted into oxide by roasting.

This method allows of the separation of zinc from the alkaline-earthy and alkaline metals, using, for the latter, barium hyposulphate in place of the sodium salt.

As iron, manganese, &c., are not precipitated by sulphuretted hydrogen in presence of the hyposulphates, the zinc may be separated from these metals and determined without the previous elimination of iron.—*Comptes Rendus* (vol. cvii., p. 341).

NOTES ON ANALYTICAL METHODS.*

By Dr. T. B. OSBORNE.

Filtration of Crude Fibre.

The filtrations in the process of determining crude fibre are commonly quite difficult and tedious, the acid liquids especially, either running turbid through a coarse filter or clogging a fine one. In most cases these troubles may be avoided by using the filter-pump and a paper filter supported on a platinum cone, and by breaking the filter down the fold or crease on one side. This is done by folding the paper so as to form a cone of an angle slightly less acute than the funnel, placing it in the latter, moistening, and then applying the suction, when the paper will usually tear apart, leaving a narrow rift from the vertex upward, across which stretches a loose network of fibres. If the sample has not been too finely ground it may be filtered clear by shaking or stirring up thoroughly, and throwing quickly on to the paper, so that the coarser particles will hold the finer and prevent the latter from passing the rift or clogging the paper. The break allows the solution to run off rapidly, so that in most cases but three or four minutes are necessary to conclude the filtration.

This method has given good results in crude fibre determinations with hay and bran-feed and with sheep-dung, which were very difficult to manage by the usual methods.

Filtration and Weighing of Silver Chloride.

Solutions containing organic matter are often very difficult to filter from silver chloride, this precipitate at first running through, and afterwards clogging the paper so as to make the filtration slow. The removal of the precipitate from the paper, and the conversion of the reduced silver obtained after burning into chloride again, are operations taking considerable care and time. In many cases it is better to allow the precipitate to settle and to decant the greater part of the liquid through a Gooch asbestos filter. The precipitate is then dissolved in a very slight excess of ammonia water, the concentrated solution being thereupon made slightly acid with nitric acid; the precipitate will separate in a flocky form, which, after carefully washing by decantation, may be thrown on to the filter and sucked dry with the pump without danger of running through. If the precipitate be fused it is somewhat difficult to remove from the crucible, but it may be

* From *Report of the Connecticut Agricultural Experiment Station* for 1887.

dried at 100°, at which temperature a constant weight is obtained in from a half to one hour.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending July 31st, 1888.

By WILLIAM CROOKES, F.R.S.;
WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To General A. De Courcy Scott, R.A., *Water Examiner, Metropolis Water Act*, 1871.

London, August 4th, 1888.

Sir,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from July 1st to July 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The London waters during the past month have continued to be of their usual excellent quality. A few samples of the East London Water Company's supply presented a slight turbidity, dependent on the exceptional circumstances explained in former reports.

We are, Sir,
Your obedient Servants,
William Crookes.
William Odling.
C. Meymott Tidy.

CONTRIBUTIONS TO A KNOWLEDGE OF THE RARE EARTHS WHICH PRODUCE ABSORPTION-SPECTRA.

By PAUL KIESEWETTER and GERHARD KRÜSS.

(Concluded from p. 76).

Gadolinite from Hitterö.

Gadolinite, a mineral so often used as a source of rare earths, has not been as yet spectroscopically examined like euxenite, fergusonite, thorite, keilhauite, &c. Therefore 120 grms. of this mineral from Hitterö were most finely powdered, evaporated down several times on the water-bath in strong hydrochloric acid, and thus fully opened up with liberation of silica. The oxalates precipitated from the hydrochloric solution formed a deep yellow oxide, the solution of which in nitric acid was concentrated on the water-bath and heated for some time. After being taken up in a small quantity of water the solution was again heated for some time on the water-bath, repeating this process five times so as to give a perfectly neutral solution of the nitrates of the gadolinite earths. It gave the following spectrum :—

Gadolinite from Hitterö.

Observed position of maximum darkness. Position of drum.	Wave-length observed.	Wave-length observed by Krüss and Nilson.	For.	Intensities of absorption-bands.
296	727·8	728·3	Diα	Rather strong.
398	690·7	690·5	Diκ	Very faint.
419	683·7	684·0	Tmα	Faint.
453	673·5	—	?	Very faint.
525	653·1	654·7	Erα	Rather faint, identified with Erα by comparison.
574	641·7	640·4	Xα	Faint.
733	605·5	—	?	Extremely faint.
788	592·9	591·5	Di	Extremely faint.
863	580·3	579·2	Diγ	Very strong.
895	575·3	575·4	Diγ	Strong.
1105	542·8	542·6	Xβ	Very faint.
1128	539·3	539·9	?	Faint $> \lambda = 539·9$.
1241	522·9	523·1	Erβ	Strong.
1257	520·9	521·5	Diδ	Rather strong.
1347	511·2	512·2	Diϵ	Faint.
1589	485·9	485·5	Xδ	Rather strong.
1728	476·6	477·7	Smβ	Very faint.
2084	452·2	452·6	Xζ	Very strong.
2203	444·1	444·7	Diι	Scarce visible.
2453	428·2	428·5	Xη	Very faint.

In gadolinite there occur a considerably larger number of rare earths than in keilhauite. Noteworthy is the absence of Smα, and of Diζ, Diη, and Diθ in the gadolinite material at the author's disposal, as well as the occurrence of Diκ for the nitrate of which the line $\lambda = 690·5$ could be observed in the spectrum. Diκ had been previously found by Krüss and Nilson only in the cerite of Bastnäs, and in no other of the minerals examined. The line $\lambda = 539·9$ was also observed which had been previously detected by Krüss and Nilson in the spectra of the holmium material, and that of the earths of the wœhlerite and thorite of Brevig, though it had not been identified with any line previously observed. Two lines were also observed at $\lambda = 673·5$ and $\lambda = 605·5$, but they could not be distinctly ascribed to any of the earths.

Above all it must be pointed out how unfavourable is the choice of gadolinite which has been so often employed for obtaining the erbium and didymium earths. The advantage of its relatively large proportion of yttrium earths can scarcely counterbalance the disadvantage of its great complexity unless better methods for the separation of the rare earths are discovered. As a proof the authors give the qualitative composition, as ascertained by spectroscopic examination of twelve principal fractions, into which the earths of gadolinite are resolved by fractionated decomposition of the nitrates according to their basicity. (See Table next page).

In all the fractions the nitrates of a whole series of earths are always simultaneously present, and gadolinite behaves like euxenite and fergusonite. Even in those fractions in which, among the earths producing absorption-spectra, only Tmα and Erα were present, or Tmα alone, the colourless ytterbia was jointly present. If, therefore, we use, as was often attempted, gadolinite, euxenite, and other minerals containing a great number of rare earths, we shall succeed in isolating one or the other element only if we have at the outset a great weight of material, say 20—25 kilos. We shall effect our purpose more readily if we select as our starting-point a minera containing a relatively small number of the rare earths. In the first place the earths of keilhauite will be worked up in quantity, and the isolation of Xζ, Diδ, and Erβ attempted. — *Berichte der Deutsch. Chem. Gesellschaft*, vol. xxi., p. 2310.

Observed position of maximum darkness.		Wave-length observed by Krüss and Nilson.	For	Intensity of absorption-bands in spectra of fractions.				
Position of drum.	Wave-length observed.			Fraction I.	Fraction II.	Fraction III.	Fraction IV.	Fraction V.
296	727·8	728·3	Diα	Very strong.	Very strong.	Strong.	Faint.	Very faint.
398	690·7	690·5	Diκ	Very faint.	Scarce visible.	—	—	Scarce visible.
419	683·7	684·0	Tmα	—	—	—	—	—
453	673·5	—	?	Faint.	Very faint.	Scarce visible.	Scarce visible.	Scarce visible.
525	653·1	654·7	Erα	Faint.	Faint.	Faint.	Faint.	Rather strong.
574	641·7	640·4	Xα	Faint.	Fainter than λ=654·7.	Very faint.	Very faint.	Very faint.
733	605·5	—	?	Very faint.	Very faint.	—	—	—
788	592·9	591·5	Di	Faint.	Very faint.	Extremely faint.	—	—
863	580·3	579·2	Diγ	Very strong.	Very strong.	Very strong.	Rather faint.	Rather faint.
895	575·3	575·4	Diγ	Very strong.	Very strong.	Strong.	Faint.	Faint.
1105	542·8	542·6	Xβ	Very faint.	Very faint.	Scarce visible.	Scarce visible.	Faint.
1128	539·3	539·9	?	Very faint; > *l*=542·6.	Rather stronger than λ=539·9.	Much stronger than λ=539·9.	Very faint; > λ=539·9.	Rather faint.
1241	522·9	523·1	Erβ	Very strong.	Very strong.	Very strong.	Strong.	Very strong.
1257	520·9	521·5	Diδ	Strong.	Strong.	Rather strong.	Rather faint.	Strong.
1347	511·2	512·2	Diε	Faint.	Faint.	Very faint.	Scarce visible.	—
1589	485·9	485·5	Xδ	Rather strong.	Rather strong.	Rather faint.	Rather faint.	Rather strong.
1728	476·6	477·7	Smβ	Very faint.	Very faint.	Scarce visible.	Scarce visible.	Scarce visible.
2084	452·2	452·6	Xζ	Very strong.	Very strong.	Very strong.	Very strong.	Very strong.
2203	444·1	444·7	Diι	Scarce visible.	Scarce visible.	Scarce visible.	Scarce visible.	Scarce visible.
2453	428·2	428·5	Xη	Rather strong.	Rather faint.	Scarce visible.	Scarce visible.	—

BROMINE *VERSUS* CHLORINE FOR GOLD EXTRACTION.

By W. H. BURFEIND.

Everyone who has worked ores by the Plattner process and has studied its details will acknowledge its chemistry perfect, and that it gives excellent results *if* carefully manipulated on suitable material. However, excellent as it is, this "if" often proves a serious obstacle. The cost of the plant is large. Heavy, bulky, and perishable generators are necessary. The vats of a medium-sized plant cover a large area. The building containing them must be large. A good deal of expensive tubing is consumed. A large supply of sulphuric acid, manganese, and salt must be on hand. The former is very expensive where freights are high. Not only the operator, foreman, or superintendent, as he may be called, must thoroughly understand the process, but also the other help must be skilled and trustworthy. Every part of the manipulation must be carefully attended to, or the result will disgust the operator and prove a loss to the owner.

I will demonstrate my views by giving a method for assaying gold ores with bromine water. The chemistry of this method is exactly that given by Plattner. I simply employ bromine in place of chlorine as a solvent. The operation is as follows:—

Bromine Assay of Gold Ores.

Weigh out the material, more or less according to richness, roast, with or without salt if sulphides are present, put it in to any kind of a bottle which will hold about one-third more than the quantity to be treated (a one-half gallon acid bottle will answer well for three or four pounds material), then add bromine water of any strength so that it will stand an inch or two over the ore, cork the bottle and shake well for a short time, let stand about an hour, giving it an occasional shake. If the gold is not too coarse and there is by this time still free bromine in the bottle the solution is complete, otherwise more bromine water must be added and additional time given. Pour the contents of the bottle into a filter, wash thoroughly with cold water until the wash water is not any more darkened by a solution of ferrous sulphate, best seen in a porcelain evaporating dish. Treat the filtrate in the same manner as if chlorine gas had been used.

All that is necessary for this test is a bottle and bromine water; both are found in every laboratory. Gas generator with tubing and receiver are superfluous. The ore cannot be put in too wet or too dry; there is no danger of packing it too tight or uneven, but it can be put into the bottle promiscuously, wet or dry. By shaking it with the bromine water, every particle of it will come into contact with the bromine. The "occasional shake" offers a fresh, bright surface to the bromine, which saves time in all cases, but is of special benefit if the gold is alloyed with quite an amount of silver. (Being once in a hurry to determine the gold left in the tailings I simply shook a small amount of ore with bromine water for 10 minutes, filtered it off, and found only a trace just visible from a 150 dollar ore). No unpleasant gases fill the laboratory if the filtering is done under a hood. The presence of free bromine is as easily detected as that of free chlorine. It is also a sign that enough has been added. The operator, if working on one kind of material, will soon know the exact amount of bromine necessary.

The time consumed is less, results will agree to a nicety with the most carefully manipulated test made with chlorine gas; and what is best, skilful manipulations do not enter into any part of the process. It can, therefore, be executed by any asssistant.

A good many of the above advantages are obtained if bromine water is used in place of chlorine gas on a large scale. A series of tests made on a large scale verified my conclusion; but I am not in a position to test this as fully as I would like.

The main objection to using bromine on a large scale. is the danger in shipping and handling large quantities of it, and, I may add, that this is the only one under a good many circumstances. I must confess that I am at a loss to overcome this last and main trouble. To ship it in the shape of bromides will not answer, as it destroys all the advantages offered. It has occurred to me that it might be possible that it can be shipped as nitro-glycerin in an absorbent. I have not at present the convenience to follow this up, and should be pleased to learn that parties interested in the manufacture of bromine have already discovered a suitable method. As soon as bromine can be handled and shipped without danger, it will be used very extensively in the Western mining region.—*Engineering and Mining Journal.*

Intensity of absorption-bands in spectra of fractions.

Fraction VI.	Fraction VII.	Fraction VIII.	Fraction IX.	Fraction X.	Fraction XI.	Fraction XII.
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	Very faint.	Faint.	Faint.	Faint.	Faint.	Faint.
—	—	—	—	—	—	—
Faint.	Faint.	Faint.	Scarce visible.	—	Faint.	Scarce visible.
Scarce visible.	Scarce visible.	Scarce visible.	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
Scarce visible.	—	—	—	—	—	—
—	—	—	—	—	—	—
Scarce visible.	Scarce visible.	Scarce visible.	—	—	Scarce visible.	—
Scarce visible.	Scarce visible.	Scarce visible.	—	—	Scarce visible.	—
Rather strong.	Rather strong.	Rather strong.	—	—	Rather strong.	Rather faint; little stronger than $\lambda=654{\cdot}7$.
Very faint.	Faint.	Very faint.	—	—	Faint.	—
—	—	—	—	—	—	—
Faint.	Rather faint.	Rather faint.	—	—	Rather faint.	Very faint.
—	—	—	—	—	—	—
Faint.	Faint.	Rather faint.	—	—	Very faint.	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—

GEOMETRICAL ILLUSTRATIONS OF NEWLANDS' AND MENDELEEFF'S PERIODIC LAW OF THE ATOMIC WEIGHTS OF THE CHEMICAL ELEMENTS.*

By the Rev. SAMUEL HAUGHTON, M.D.

Part I.—The First and Second Periods of Seven Elements following Hydrogen; or, the Carbon-Silicon Double Period.

I assume on the part of my readers a general knowledge of Newlands' "Law of Octaves," of Mendeleeff's "Periodic Law," and of Reynolds's graphic representation of the results arrived at by their successors on this remarkable subject.

I reproduce in Plate I., with Dr. Reynolds's permission, the most recent graphic representation of the "Periodic Law."

In this diagram the elements are plotted according to their atomic weights and valencies; the vertical co-ordinates being atomic weights and the horizontal co-ordinates being valencies, counted (for convenience of plotting) positive or negative, according as the element belongs to an odd or even period of seven.

First Period or Carbon Period.

	Element.	Atomic Weight.	Valency.
1.	Lithium	7	Monad.
2.	Beryllium	9	Dyad.
3.	Boron	11	Triad.
4.	Carbon	12	Tetrad.
5.	Nitrogen	14	Triad.
6.	Oxygen	16	Dyad.
7.	Fluorine	19	Monad.

Second Period or Silicon Period.

	Element.	Atomic Weight.	Valency.
1.	Sodium	23	Monad.
2.	Magnesium	24	Dyad.
3.	Aluminium	27	Triad.
4.	Silicon	28	Tetrad.
5.	Phosphorus	31	Triad.
6.	Sulphur	32	Dyad.
7.	Chlorine	35½	Monad.

* Abstract of a Paper read before the Royal Irish Academy, April 28, 1888.

In Plate II. I show on an enlarged scale Dr. Reynolds's diagram for the above-named Carbon and Silicon Periods following hydrogen. This diagram is formed by joining together by right lines the successive fourteen points, commencing with lithium and ending with chlorine. If the points were at random the number of right lines would be thirteen; and this would be the order of the curve passing through the fourteen points, and an infinite number of such curves could be drawn, and the problem would be geometrically indefinite. The points being supposed placed at random, it is well known that a single general quartic curve can be drawn through them, and one only, thus giving an unique geometrical solution.

A general quartic curve is therefore the simplest solution that the collocation of fourteen points admits of in its most difficult form; but this solution may become simpler if the points are arranged by a law or method and not at random.

In the problem now before us we find on inspection that five of the fourteen points lie on the same straight line,* viz.:—

C | N | O | Mg | Si.

This is shown in Plate III.

This line joins the two tedrads, carbon and silicon, and passes through the point 20 of the line of atomic weights.

There remain nine points not accounted for, viz:—

Li | Be | B | F | Na | Al | P | S | Cl.

These nine points are found to lie upon a simple serpentine cubic with one real asymptote, which I have plotted in Plate III.

Taking the point 20 for origin, the co-ordinates of the nine points are as follows:—

		x.	y.
1.	Lithium	−13	−1
2.	Beryllium	−11	−2
3.	Boron	− 9	−3
4.	Fluorine	− 1	−1
5.	Sodium	+ 3	+1
6.	Aluminium	+ 7	+3
7.	Phosphorus	+11	+3
8.	Sulphur	+12	+2
9.	Chlorine	+15½	+1

* The chances are millions to one against this happening at random.

Plate I.

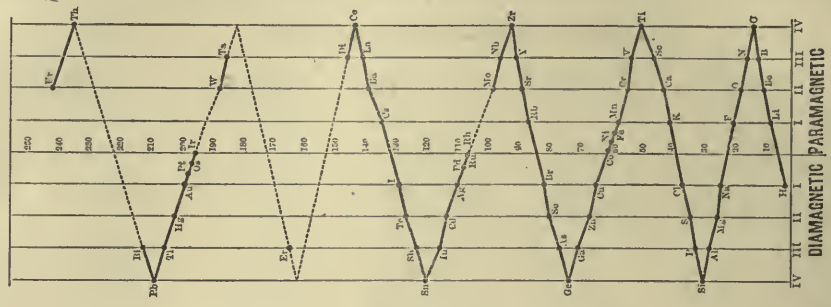


Plate II.

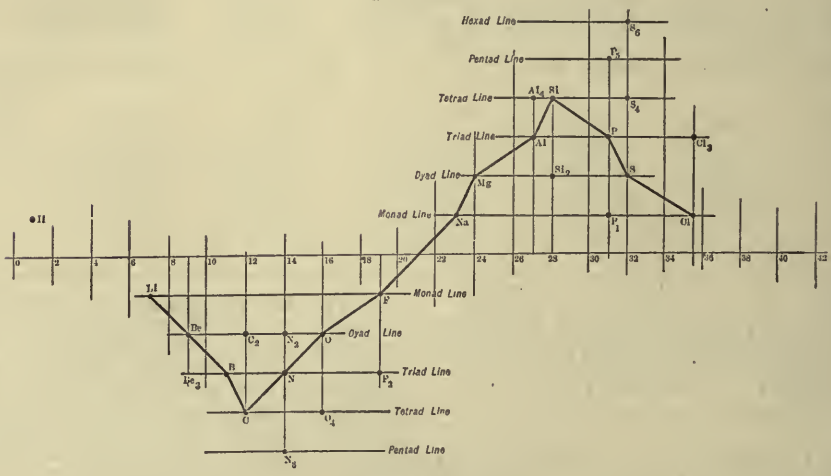
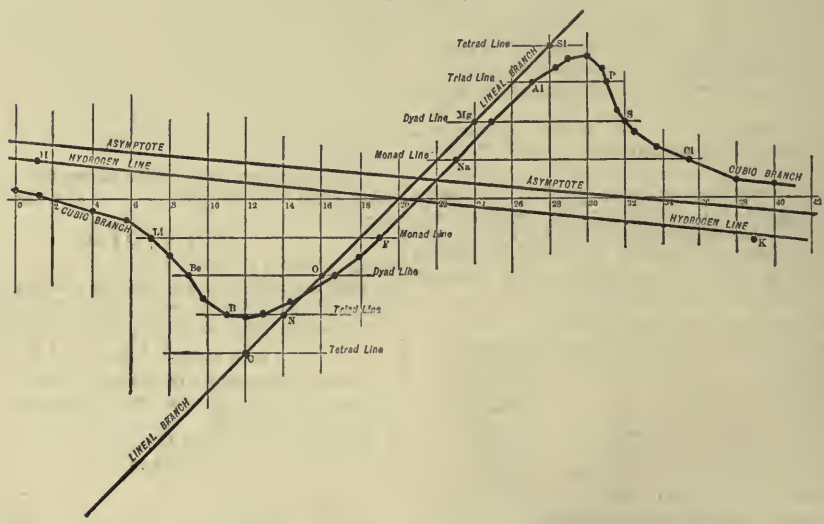


Plate III.



By means of this table the nine unknown co-efficients of the cubic can be found, and the curve plotted with its asymptote as I have done in Plate III.

The total curve consists of—

(*a*) the lineal branch ;
(*b*) the cubic branch ;

and there is a possibility of forming an element wherever the monad, dyad, triad, or tetrad lines intersect the curve.

The first three elements, viz. :—

Li | Be | B,

group themselves upon the cubic branch, and also the last three elements, viz. :—

P | S | Cl,

are found upon the cubic branch.

The fourth element, carbon, is found upon the lineal branch, and could not occur upon the cubic branch, which

lies altogether inside the tetrad line, and the same remark applies to the eleventh element, silicon.

In the remaining six elements lying between carbon and silicon, what (for want of a better word) I may call a "contest" takes place between the lineal branch and the cubic branch as to which of them shall have the element, but in no case are two elements formed with the same valency.

1. In the triad line nitrogen is formed on the lineal branch, but there is distinctly intimated the possibility of another element on the cubic branch with the atomic weight 13, where the cubic, having passed through boron, again intersects the triad line.

2. On the dyad line oxygen is formed on the lineal branch, but the possibility is shown of another element on the cubic branch with the atomic weight 16·4

3. On the monad line fluorine is formed on the cubic branch with a possibility of another element on the lineal branch of atomic weight 18.

4. Again sodium is formed on the cubic branch with a possibility of an element on the lineal branch with atomic weight 22.

5. Magnesium is formed on the lineal branch with a possibility of another element on the cubic branch with atomic weight 25.

And lastly, aluminium appears on the cubic branch with a possibility of another element on the lineal branch of atomic weight 26.

These two periods of seven elements each form the first two octaves of the chemical harmony of the universe; but what are we to do with hydrogen, which remains alone outside the harmony?

Mendeleeff thought that his six missing brothers and sisters were to be sought between hydrogen and lithium; but Dr. Reynolds easily proved that they must be sought for behind hydrogen, which is the last note of the primeval octave. Are they to be found between zero and unity or looked for "behind the looking-glass" in the unknown land of negative atomicities, where heat, light, and electricity reside?

However this may be I think it useful to point out a remarkable relation between hydrogen and the fourteen elements which follow it in atomic weight.

If we take the common centre of gravity of the fourteen elements (regarded as equal weights) and join this point with the point representing hydrogen, the line so found is very nearly parallel to the asymptote of the cubic curve drawn in Plate III.

The difference in direction between the two lines is only 20′ arc.

Hydrogen, the first born and king of the elements, sits alone without brothers or sisters, and seems to resemble the fabled Isis of Egyptian mythology—

Ἐγώ εἰμι πᾶν τὸ γεγονός καὶ ὄν, καὶ ἐσόμενον, καὶ τὸν ἐμὸν πέπλον οὐδείς πω θνητὸς ἀπεκάλυψε.

NOTE.

Table of Fifteen Elements, with Name of Discoverer and Date.

Element.	Name.	Date.
1. Hydrogen.	Cavendish.	1781
2. Lithium.	Arfwedson.	1817
3. Beryllium.	Wohler.	1828
4. Boron.	Gay-Lussac and Thenard.	1808
5. Carbon.	—	Prehistoric.
6. Nitrogen.	Rutherford.	1772
7. Oxygen.	Priestly.	1774
8. Fluorine.	Moissan.	1886
9. Sodium.	Davy.	1807
10. Magnesium.	Davy.	1808
11. Aluminium.	Wohler.	1828
12. Silicon.	Berzelius.	1823
13. Phosphorus.	Brandt.	1669
14. Sulphur.	—	Prehistoric.
15. Chlorine.	Scheele.	1774

(To be continued).

CORRESPONDENCE.

ESTIMATION OF SULPHUR IN IRON AND STEEL.

To the Editor of the Chemical News.

Sir,—Referring to the correspondence now proceeding in your paper *re* "The Estimation of Sulphur in Iron and Steel," I cannot quite make out what Mr. Morgan purposes to show in his article (Chemical News, vol. lviii., p. 63), the processes therein detailed being old standing methods employed in every Steel Works Laboratory, and the errors he points out as liable to occur are such as no experienced chemist would be in danger of falling into. With care almost the exact moment can be judged when the acid solution shall be basic, and if evaporation is carried beyond this point the iron is immediately precipitated. The most important point to be watched in working the $BaCl_2$ process is, I find, the impurities in the reagents; the purest acids I have been able to procure contained 0·007 per cent sulphur, and many samples contain as high as 0·013 per cent, calculated on 5 grms. of steel, although sold as *Sulphur Free*.

With regard to Parry's colorimetric process, Mr. Morgan observes that with "practice" the precipitation of PbS may be avoided even in working on a steel containing as high as *over* 0·2 per cent sulphur (rather high sulphur that; we do not get them so high in Sheffield as a rule). Although I have had considerable practice, I always get a precipitate when estimating a steel containing 0·06 or over; while by the method published by Messrs. Arnold and Hardy I can get good and concordant results, their self-registering method working exceedingly regularly, and the time thereby saved where accurate results are indispensable is a great point gained over the $BaCl_2$ method, where to obtain an accurate result, especially in a very low sulphur steel, quite two days are required, not to mention trouble of manipulation. Mr. Morgan states it does not signify whether the H_2S is evolved rapidly or slowly. I have found quite the reverse to be the case: if the gas be evolved slowly precipitation is not so likely to take place as when it rushes off rapidly, thereby agitating the volume of solution contained in the cylinder. Mr. Morgan states he has difficulty in obtaining regular steels to use as standards. I think there would be some little difficulty in obtaining standards to meet the range he mentions, 0·02 to 0·2 and over. To meet this range, and to obtain an estimation of an unknown steel, about eight standards would have to be weighed out and dissolved, thus making nine weighings for a single result, whereas the method proposed by Messrs. Arnold and Hardy would meet the case in a single operation. Again, let Mr. Morgan work in an atmosphere of hydrogen, and he will find that he gets much more reliable results than when working in atmospheric air, where a portion of his H_2S is liable to be oxidised.—I am, &c.,

B. W. Winder.

The Laboratory,
Bessemer Road, Attercliffe.

British Association for the Advancement of Science.—It is proposed by the Organising Committee of Section B that, in the course of the approaching meeting, there shall be a discussion in that Section upon the subject of "Valency." Professor Armstrong will open the debate, and it is hoped that several other eminent chemists will take part. In the immediate neighbourhood of Bath there are no industries especially interesting to chemists, but arrangements are in progress by which it is hoped that members will be admitted to some of the works in and about Bristol, which is only ten miles away.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of emperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 6, August 6, 1888.

New Experiments on the Fixation of Nitrogen by Certain Vegetable Soils and by Certain Plants.—M. Berthelot.—In all the cases which the author has observed, and with the earths taken for experiment, fixation of nitrogen has taken place, as well in vessels hermetically sealed as in soils merely covered, and in those fully exposed to the air, and in bare earth as well as in presence of leguminous plants. At the outset of the growth of the latter the absorption of nitrogen falls mainly upon the soil, but as the plant becomes vigorous it draws nitrogen from the soil, which then retains merely a fraction of the total gain. The author reserves for future study the question whether a part of the nitrogen gained by a vigorous plant is not in part taken directly from the atmosphere.

On Levulose.—M. Jungfleisch and L. Grimbert.—Leaving out of the question the influence of the time elapsed since the solution of levulose has been made, and also permanent modifications resulting from an alteration in the saccharine matter, the authors have made a number of experiments which have been summed up in the following formula, in which t represents the temperature, p the weight of levulose contained in 100 c.c. of liquid :—

$$\alpha_D = -101{\cdot}38^\circ - 0{\cdot}56t + 0{\cdot}108\,(p - 10).$$

This formula is applicable at temperatures from 0° to 40°, and at degrees of concentration less than 40 per cent.

Potassium and Sodium Malonates.—G. Massol.—A thermo-chemical paper, not adapted for useful abstraction.

On Methane and Ethylene Hydrates.—M. Villard.—Methane forms with water a crystalline combination, which is destroyed only above 21·5°. The hydrate exists at temperatures much higher than the critical points of the gas, —99·5°. The crystals of ethylene hydrate are slowly destroyed at 18·7°, even under strong pressure, a temperature notably higher than the critical point of ethylene, +10·1°.

Observations on the Fixation of Atmospheric Nitrogen by Leguminous Plants whose Roots have Nodosities.—E. Bréal.—The author has studied these nodosities as obtained from acacias, peas, lupins, kidney beans, and lentils. On a microscopic examination of the nodosities he observed rounded, very refringent granules, mixed with "filaments in motion resembling bacteria." On analysis he found these nodosities decidedly richer in nitrogen than the stems and leaves of the same plants, the thick roots, or the root-fibres.

Zeitschrift fur Analytische Chemie. Vol. xxvii., Part 2.

Methods of Separating and Determining Arsenic, Antimony, and Tin.—E. Lesser.—The author gives the preference to the process of F. W. Clarke (Chemical News), with the following precautions. The solution of the metals is neutralised, as far as possible, so as to admit of a complete precipitation of the antimony. So much oxalic acid is then added that it may be from 35 to 40 times the weight of the tin. The approximate quantity of tin is found by taking the sulphides thrown down by sulphuretted hydrogen from a distinct portion of the sample, oxidising with nitric acid, filtering off the insoluble residue of stannic oxide and antimony tetroxide, igniting in a tared crucible, and weighing. After the addition of oxalic acid the solution is heated, and sulphuretted hydrogen passed in to saturation, when the precipitate is filtered off. The metallic sulphides are dissolved in ammonium sulphide and, after acidulation with oxalic acid, again treated, hot, with sulphuretted hydrogen, in order to remove the small quantity of tin which was carried down in the first precipitation. The two filtrates containing the tin are mixed, concentrated, and precipitated according to Clarke's directions with ammonia, ammonium sulphide, and acetic acid, the precipitate being then determined in the ordinary manner as tin oxide. For separating the arsenic and antimony, the sulphides are dissolved off the filter into a beaker in warm ammonium sulphide and then oxidised with hydrochloric acid and potassium chlorate. The solution is mixed with tartaric acid and ammonia in excess, and the arsenic acid is precipitated with magnesia mixture. In order to remove basic magnesium tartrate from the precipitate, it is redissolved in hydrochloric acid, and, with the addition of a little magnesia mixture, once more precipitated with ammonia. The ammonium-magnesium arseniate is then weighed with the ordinary precautions. The filtrate is acidified, and the antimony precipitated with sulphuretted hydrogen; the antimony sulphide is converted into tetroxide and determined as such.

Studies on the Kjeldahl Process for Determining Nitrogen.—F. W. Dafert.—The bodies which are directly amenable to the Kjeldahl process are :—All amides and ammonium bases, the pyridin and chinolin bodies, the alkaloids, the bitter principles, the albumenoids, and kindred substances. The following bodies require previous preparation :—All nitro-, nitroso-, azo-, diazo-, hydrazo-, and amido-azo-compounds, the compounds of nitric and nitrous acid, the hydrazines, and probably the cyanides. For the nitro-compounds the author proceeds as follows :—The substance in question is dissolved in 10 c.c. of alcohol (or, if very resistant, at once in ordinary oil of vitriol), mixed with zinc powder, and heated with the addition of 10 c.c. of oil of vitriol until the alcohol is expelled. He then adds 10 c.c. of "acid mixture" (which is made up of 1 litre rectified monohydrated sulphuric acid and 200 grms. phosphoric anhydride) and mercury and proceeds in the ordinary manner. In distilling with soda-lye caution must be used, as the flasks are apt to burst in consequence of the dense coating of sulphide. It is best to heat upon the sand-bath with frequent shaking. Nitroso-derivatives may also be treated in this manner.

Determination of Sulphur and of the Halogens in Organic Bodies.—Peter Claesson.—The author conducts the combustion, not in a current of oxygen, but of common air, which he charges with the requisite nitrous vapours in the combustion tube. A single tube for the introduction of gases is sufficient, instead of the two currents shown in *Zeitschrift* (xxvi., p. 372, Fig. 40). The nitric acid is absorbed in four cylindrical cages of platinum wire, filled with small glass beads, and introduced into the combustion tube. They absorb about 8 c.c. of red fuming nitric acid. The combustion tube is charged exactly as in the author's earlier arrangements, but between the platinum wire cages 1 and 2, *not* containing nitric acid, then come two of the cylindric cages just mentioned ; then, behind the boat, an ordinary platinum wire cage, and then, at a little distance, two cylindrical cages containing nitric acid. The two empty platinum cages situate at the drawn out end are first heated to redness; then, about 1 c.m. behind each nitric cage, a small flame is lighted, whilst a slow current of air is drawn through the combustion tube. When the tube is thus filled with nitrous vapours heat is applied to the substance proceeding in an opposite direction to the current of air. The contents of the tube between the acid cages nearest the point and the boat must always be red, otherwise the heat of the substance must be reduced or the current of nitric acid must be reinforced. The vapours issuing from the tube must always be red. Finally, the nitric acid remaining in the cages, and any sulphuric acid which may have been formed, are driven by heat into the

receiver, let cool, the cages are emptied out into a capsule, and rinsed with water. The washings and the water used in rinsing out the tube are added to the contents of the receiver, which are then treated as in the author's former memoir.

Contributions to a Knowledge of Hydrocyanic Acid and of Cyanogen Iodide.—E. von Meyer.—From the *Journal für Prakt. Chemie.*

Detection and Determination of Micro-organisms in the Air.—R. J. Petri.—The micro-organisms suspended in the air are filtered out in a sand-filter. The filter, charged with germs, is divided into convenient portions, placed in flat double capsules, and mixed with gelatin. The colonies which develop are counted, and in this manner the micro-organisms are estimated in the volume of sand examined. The sand used for the filters should have its granules of the size of 0·25 to 0·5 m.m., and must have been previously ignited. It is introduced into a glass tube 8 to 9 c.m. in length, in the state of two plugs supported by small wire nets, each plug being 3 c.m. long and from 1·5 to 1·8 wide. The two filters come in contact at the middle of the tube, both ends of which are firmly closed with plugs of cotton-wool. For the experiment these plugs are removed, and one end of the tube is connected by means of a lead tube with a sufficiently powerful filter-pump. The aperture of the filter through which the air enters is turned upwards. The quantity of air passed through the apparatus is determined by means of a gas-meter. Not more than 10 litres should be passed in one to two minutes, the speed of the air current in the sand not exceeding 0·7 metre per second. The sand charged with germs is preferably sown at once, though a delay of seven weeks does not seem to occasion any injury. It is sown in double capsules of 9 c.m. in diameter. The plug of sand first traversed by the air, which has taken up all the microbia from the volume of air, is distributed in a suitable number of such capsules and covered with liquid gelatin. The sand from the second plug should be free from germs.

Examination of Honey.—K. Kayser.—The residue from the fermentation of pure honey is, as a rule, optically inactive, and, if heated with hydrochloric acid, it contains only exceptionally traces of reductive sugar. Sieben's first two methods for the examination of honey should therefore be modified as follows:—25 grms. honey are mixed with 12 grms. solid yeast (free from starch), and made up with water to 200 c.c., and let ferment for forty-eight hours at a medium temperature. Aluminium hydroxide is then added and the mixture made up to 250 c.c.; 200 c.c. of the clear filtrate are concentrated to 50 c.c. and polarised in a 200 m.m. tube. A deflection of more than 1° (Wild) proves that starch sugar has been added. 25 c.c. of the liquid used for polarising are then mixed with 25 c.c. water and 5 c.c. strong hydrochloric acid and heated for an hour in a boiling water-bath, neutralised, made up to 100 c.c., and any sugar formed is determined by Allihn's method in one quarter of the liquid. The sugar thus found, multiplied by 40, gives the quantity of sugar which comes to the fermentation residue from 100 grms. of honey. If this exceeds one per cent starch sugar has been added.

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PATENTS, DESIGNS, & TRADE MARKS ACT, 1883.

In the Matter of Letters Patent granted to CHRISTIAN EMIL BICHEL, of Berlin, in the Empire of Germany, for "Improvements in the manufacture of Explosive Compounds," dated 11th November, 1886, No. 14623.

NOTICE IS HEREBY GIVEN that the said C. E. BICHEL has applied for leave to amend the Specification numbered as above.

A copy of the Specification as proposed to be amended can be inspected at the Patent Office; and particulars of the proposed amendment were set forth in the Official Journal of the Patent Office issued on the 14th July, 1888.

Any person intending to oppose the said application must leave notice of objection thereto (on Form G) at the Patent Office, 25, Southampton Buildings, London, W.C., within one Calendar onth from the date heref.

mDated this 14th day of July, 1888.

H. READER LACK, Comptroller-General.

PATENTS, DESIGNS, & TRADE MARKS ACT, 1883.

In the Matter of Letters Patent granted to FRANCIS BRISTOW RAWES, of Stratford, in the County of Essex, for "Improvements in and in Apparatus for obtaining Sulphur and some of its Compounds, and in the treatment thereof, and also of the associated products," dated 22nd March, 1882, No. 1393.

NOTICE IS HEREBY GIVEN that the said F. B. RAWES has applied for leave to amend the Specification numbered as above.

A copy of the Specification as proposed to be amended can be inspected at the Patent Office; and particulars of the proposed amendment were set forth in the Official Journal of the Patent Office issued on the 18th August, 1888.

Any person intending to oppose the said application must leave notice of objection thereto (on Form G) at the Patent Office, 25, Southampton Buildings, London, W.C., within one Calendar month from the date hereof.

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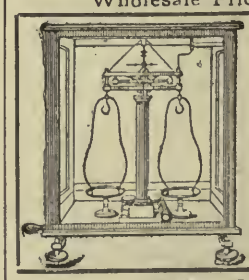

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1501.

ON RHINANTHIN.

By Dr. T. L. PHIPSON, F.C.S.

In my *Journal of Medicine*, &c. (No. 100, p. 66), I noted that I had discovered a glucoside similar to digitalin in the leaves of the *Antirrhinum majus*, which flourishes abundantly in the sandy soils of Surrey. Further investigation of this substance has shown me that it is *rhinanthin*, a glucoside extracted twenty years ago by an Austrian chemist, H. Ludwig, from the seeds of *Rhinanthus hirsutus* and *R. crista-galli* (Rattle).

I find that rhinanthin exists rather plentifully in the leaves and stalks of the *Antirhinum majus* (snapdragon), and that it shows a reaction by which it can be recognised, even when present in very minute quantity in an aqueous solution. According to my experiments, rhinanthin can be extracted from the plant either by means of methylic alcohol or by cold water. The former process gives the larger yield, but the latter gives a purer product, and is in every respect easier and more economical. The plant, when fresh, is very brittle, and can be easily broken up or cut into small fragments, leaves and stalks, and allowed to remain in water in a closed vessel for a few days. The liquid is then filtered, treated with a small quantity of sub-acetate of lead (which does not precipitate rhinanthin), filtered again, and the slight excess of lead having been separated from the filtrate, the latter is evaporated carefully (on a water-bath) almost to syrupy consistency, and then the vessel is allowed to remain in a warm dry place for a few days. In these circumstances rhinanthin forms transparent colourless rhombic crystals, which are very brilliant; it can be purified by a second crystallisation from water. It has a peculiar sweetish acrid taste, and is very soluble in water and in alcohol.

The aqueous solution of rhinanthin, to which a few drops of hydrochloric acid are added, and then heated, gradually turns brown, finally deposits an amorphous dark brown precipitate (*rhinothogen*), and the supernatant solution contains glucose.

This reaction is very sensitive, and precisely similar in appearance to the brown tint developed in solutions of glucose heated with soda (for instance, diabetic urine), only in the present case the colour is produced by acid. A perfectly clear colourless solution of rhinanthin in water, placed in a test-tube with a few drops of HCl and heated, turns gradually brown, and in a few moments, just afrer the solution has reached its boiling-point, it is quite dark and opaque. A copious precipitate of rhinanthogen results, in the form of a dark reddish brown amorphous powder, which can be filtered off and washed. The filtrate contains glucose.

This rhinanthogen dissolves in hot concentrated sulphuric acid, forming a greenish black solution. It is also attacked easily by nitric acid.

Ludwig has given to rhinanthin the formula $C_{58}H_{52}O_{40}$; my analyses of this substance do not exactly correspond with his single analysis, but lead to the formula—

$$C_{64}H_{56}O_{40}.$$

Nevertheless, I have not had sufficient of the product at my disposal to pursue this subject further at present.

In treating the decoction by subacetate of lead it is well to employ as little as possible; the slight excess of lead can be removed either by carbonate of soda, phosphate of soda, or sulphuretted hydrogen. I prefer the latter, though it leaves a small quantity of acetic acid free in the liquid to be evaporated; for I have found by direct experiment that dilute acetic acid will not convert the glucoside rhinanthin, as dilute HCl does, even after boiling for a considerable time; and on the water-bath the presence of a minute quantity of free acetic acid is not, in this case, prejudicial. It is best not to evaporate to a thick syrup, but to stop as soon as indications of crystallisation occur at the edge of the liquid. The capsule is then removed to a warm, dry place, where it remains for several days; the crystals thus formed are very white and brilliant.

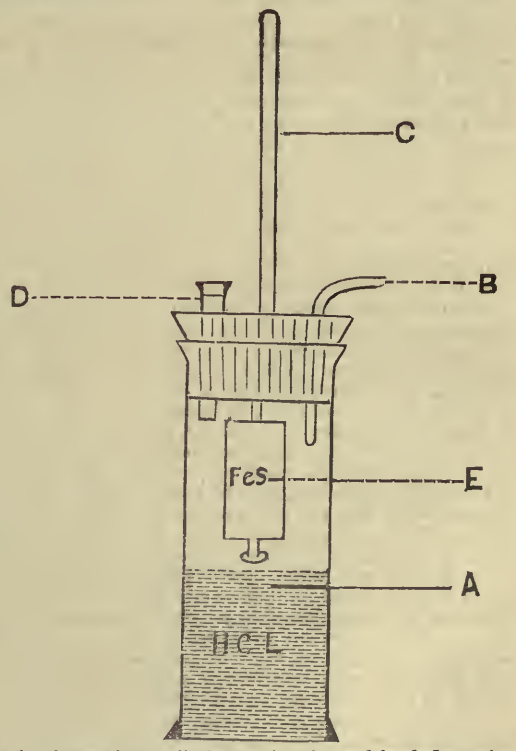
The genera *Rhinanthus*, *Antirrhinum*, and *Digitalis* all belong to the same family of plants, and probably rhinanthin will be found to possess toxic properties; perhaps the toxic properties of *Linaria* (another closely allied genus) are due to it. But whatever may be its physiological properties, it is probable that rhinanthin, like digitalin, is very liable to allotropic changes and decomposition or oxidation. I believe that most of the substances extracted from *Digitalis* are really derived from allotropic or isomeric changes and from the decomposition of digitalin, and that these changes occur during the elaborate processes of extraction.

CHEAP APPARATUS FOR GENERATING SULPHURETTED HYDROGEN.

By J. MARTIN,

Lecturer at the Diocesan College, Rendebosch, Cape Town.

The apparatus shown below for generating H_2S for a practical class was designed by me a short time ago, and has given the greatest satisfaction on the score of both cheapness and convenience. The diagram will sufficiently explain its action.



A is a large glass cylinder, such as is used for deflagration experiments, tightly fitted with a well paraffined cork with three holes. C is a stout glass rod which passes through the centre hole in the cork and through a hole in the

bottom of a cylindrical porcelain vessel, E, which is supported by the end of the rod being flattened. The bottom of the porcelain vessel is drilled with several small holes. B is the delivery tube for the gas, and D is a short wide tube so placed that its lower end is perpendicularly over the interior vessel and closed at the top with a cork. The gas is of course generated by placing FeS in the porcelain vessel and acid in the lower part of the glass cylinder, and pushing down the rod. The strength of the current can be regulated with considerable nicety. To charge the apparatus for use I take out the cork from the tube O, and drop in small pieces of FeS, which fall into the porcelain vessel. The acid is sent in through the tube B by means of a funnel and india-rubber tubing. When the acid is the first to be used up, I draw up the interior vessel to the cork, take out the cork of the tube D, and invert the whole apparatus. The liquid of course runs out, but the FeS is retained so as to fall back again afterwards to bottom of the inside cylinder. I find that friction is sufficient to support the FeS, but to prevent accidents I place a small piece of caoutchouc tubing on the rod above.

The whole apparatus only costs about three shillings. It can of course be made of all sizes.

CHINESE TREATMENT OF COBALT ORES.

By THOS. IDE BOWLER.

Having lately had occasion to visit a Chinese glass factory in Canton, I was enabled to procure specimens of the *làm po-li shek* (blue glass stone), used by these ingenious and very peculiar people for colouring glass blue, and used also for colouring porcelain. So far as I am aware, the Chinese have not the art of making colourless glass; they buy up old American or European broken glass, which they sort out according to colour and quality, and re-melt in pots 0·67 metre high × 0·40 metre in greatest breadth and 0·11 metre across the mouth, the thickness being about 0·04 metre. One, or occasionally two, of these pots are set in a small rectangular furnace of extremely primitive construction; the fuel used is anthracite, of which it takes about 3 to 4 cwts. to melt one pot of glass; the blow-irons are very light and short; the moulds are made of clay coated with coal-dust powder, while a heap of ashes and straw serves as leer or annealing oven. Yet, astonishing as the statement may appear, these Chinese workmen, with their small quaint-looking and rough apparatus, were actually engaged in the successful separation of cobalt from iron, manganese, and nickel, the proportion of the cobalt being but 2·40 per cent. The ore in its rough state is first carefully washed, and each separate piece scrubbed with a brush to free it from adhering ferruginous clay; it is then dried and reduced to fine powder under a native tilt hammer-like arrangement, worked by the foot, the mortar and pestle being both of cast-iron; the resulting powder is then ground in a hand mill with water, a little powder being from time to time ladled into the mill and washed down with water. The powdered ore and water flows out into an earthenware receptacle, and at the end of the day a workman stirs the ore and water carefully together, leaving the same to settle until the next morning, when he carefully pours off the water and then proceeds to reject the upper portion of the powder, by which means he gets rid of almost all the gangue, the heavier portions below consisting, for the most part, of iron, manganese, nickel, and cobalt oxides. This bottom portion is then dried, mixed with a little borax, and stirred up in the pot with a lot of old broken glass. The colour for the first twelve hours is a dirty greenish black; this gradually gives way to a light blue, showing more or less the amethyst tint imparted by the manganese, but both the iron and nickel appear to have been almost completely deoxidised, for after about thirty-six to forty hours, firing the colours imparted by these two metals are scarcely apparent in the glass. The bottom portion of glass in the pot is discarded as black or worthless.

For painting on porcelain the Chinese frit this same ore with felspar, white kaolin clay, and a large quantity of borax; the frit thus produced is ground up to a very fine powder and used for painting upon the biscuit, the *modus operandi* being, in Canton, as follows:—The workman first takes the burned biscuit; he then coats it with a white glaze of borax, felspar, and clay, and when this is dry he paints upon it, burning in both glaze and colour at one operation. The biscuit kiln is a circular beehive-like arrangement, with a firing door for the wood fuel at one side and three low chimneys at the other, the openings into the chimneys being at the bottom of the kiln, opposite the firing door. This latter is almost completely closed by bricks during firing, leaving only a little hole, some few inches square, for insertion of the fir boughs and dried grass used as fuel.

The sample of ore examined showed:—

Iron oxides	35
Manganese oxides	13·10
Nickel oxides	3·50
Cobalt oxide..	2·40
Gangue	46·00

The gangue consisted mainly of silica with aluminic silicates. The ore is found at the base of a range of sandstone hills near the town of Tsang-sheng, the geological formation being probably Upper Cambrian.

Geological research in China is carried on under extreme difficulty in a country where, outside the narrow limits of the treaty ports, one carries one's life in one's hand, and amongst a hostile population, whose most friendly greeting is "*Sat ne fanqui lo*" ("Behead you foreign devil") or "*pah shan*" ("mountain climber"), meaning tiger, and the expression is a sort of invitation to the neighbours to join in exterminating the obnoxious visitor.

By-the-bye, how is it that in almost any work treating on metals or alloys one finds reference to the expression "pak-fong"? There must be in scientific writings, I fear, a minimum of original research and a great deal of plagiarism. The first writer, probably one of the earlier Jesuits, in describing the well-known Chinese alloy of copper and nickel in varying proportions with zinc and some other metals, wrote "pak-tung," white copper, the correct Chinese term; a printer's error made it "pack-fong," and everybody else has copied from this. It should be "pak-tung."

Hong-Kong, July 16, 1888.

ON PALLADIUM ALLOYS IN WATCHES.

By Professor EDWIN J. HOUSTON.

At the meeting of the American Philosophical Society on April 6th last Professor Houston stated that he had concluded his experiments on the Paillard watches. The following results were reached, viz.:—

A watch whose balance-wheel, hair-spring, and escapement are made of the Paillard palladium alloys can not have its rate sensibly affected by the influence of any magnetic field into which it is possible to bring it while on the person of its wearer.

In order to test this, such watches were carried into exceedingly powerful magnetic fields, and although carefully rated, both before and after exposure, no sensible change in their rate could be detected.

Experiments showed that the palladium alloys are entirely destitute of any paramagnetic properties. As far as the amount of the alloys at the author's disposal permitted, experiments failed to show that they possessed any diamagnetic properties

A number of these alloys are made by Mr. Paillard. The composition of four described by him in his U.S. patents, and numbered for convenience Nos. 1, 2, 3, 4, is as follows, viz.:—

Palladium Alloy, No. 1.

Palladium	60 to 75 parts
Copper	15 to 25 ,,
Iron	1 to 5 ,,

Palladium Alloy, No. 2.

Palladium	50 to 75 parts
Copper	20 to 30 ,,
Iron	5 to 20 ,,

Palladium Alloy, No. 3.

Palladium	65 to 75 parts
Copper	15 to 25 ,,
Nickel	1 to 5 ,,
Gold	1 to 2½ ,,
Platinum	½ to 2 ,,
Silver	3 to 10 ,,
Steel	1 to 5 ,,

Palladium Alloy, No. 4.

Palladium	45 to 50 parts
Silver	20 to 25 ,,
Copper	15 to 25 ,,
Gold	2 to 5 ,,
Platinum	2 to 5 ,,
Nickel	2 to 5 ,,
Steel	2 to 5 ,,

The complete masking of the paramagnetic properties of some of the ingredients of these alloys is of considerable interest, and would seem to indicate a true chemical union of their constituents. The most interesting results of these experiments, however, were those in which it was established that no matter of what materials the balance-wheel or hair-spring may be made, provided they are conductors of electricity, their movements through a magnetic field, when the moving masses properly cut the lines of force, must result in a change in their rate of movement, and consequently in a change in the rate of the watch; or, briefly, it was established that *a watch placed in a magnetic field acts like a dynamo-electric machine.*

The amount of this action is exceedingly small. In order to detect it a very powerful magnetic field must be employed, and the watch subjected to its influence for an hour or more.

In order to obtain this field, and to properly concentrate it on the rim of the balance-wheel (thus placing said rim in a position analogous to the copper disk in the well-known experiment between the poles of an electro-magnet), Prof. Houston mounted massive conical pole pieces, of soft iron, inside the pole pieces of the armature field of an Excelsior arc-light machine, whose armature had been removed. The space left between the opposing ends of these pole pieces was just sufficient to permit the introduction of the watch.

The watch was then securely fixed in place, with its face upwards, so that the lines of magnetic force, concentrated on that part of the edge of the balance-wheel nearest the edge of the watch, passed through it at right angles to the plane of its movements. After an exposure of one hour to the influence of this extraordinary field, *the watch was found to have gained fifteen seconds.*

The author believes that the cause of the gain is to be ascribed to a decrease in the arc of oscillation of the balance-wheel, which would thus result in an increase in the rapidity of its movements.

The fact that the watch, after its removal from this powerful field, did not manifest any sensible change in its rate, shows the extent of the protection the palladium alloys give it against the effects of external magnetism.

FILTRATION WITH FILTERS OF METALLIC FELT.

By CHARLES E. MUNROE.

Gooch's admirable filter of asbestos felt* is too widely known and extensively used to require description, and his ingenious modification of it in which volatile felts† are employed is recognised as forming a useful extension of the method for certain applications. Some time since it occurred to me that another modification might be wrought if we were to use, for the manufacture of the felts, metallic salts which were easily decomposed on ignition, and which, when decomposed, left the metal as a spongy coherent residue. Such a salt is found in the ammonium platinic chloride, and by its use I have obtained the metallic felt which served very nicely for this purpose.

To produce this filter I precipitated platinum chloride with ammonium chloride, using a slight excess of the reagent, and washed the salt thoroughly, first with water and then with alcohol. Then taking a Gooch filtering crucible of platinum I placed it on a thick piece of bibulous paper and poured in the moist salt. The alcohol ran through the peforations in the crucible and was absorbed by the bibulous paper, while the salt remained behind, the filtering crucible being filled in this way to a height of about 5 m.m. The crucible was then carefully cleaned and dried, the cap and cover put on, and the whole ignited, thus driving off the volatile constituents and leaving a spongy coherent residue of metallic platinum well distributed over the perforated bottom of the crucible. In order to prevent the sponge from cracking and curling it was found essential to dry and ignite the salt quite cautiously, but in some instances where cracks did appear they were easily and effectually closed by gently rubbing with a glass rod, while in other cases the crevices were filled with a fresh portion of the ammonium platinic chloride and the drying and igniting repeated. The latter method was also employed when it was thought desirable to increase the thickness of the felt. After a short trial the preparation of the felt became quite easily and readily accomplished. The prepared filters are used in the same way as Gooch's asbestos filters are, the caoutchouc gasket described in my paper on the "Use of Porous Cones in Filtration,"‡ being employed to secure an air-tight joint. The platinum felt may be easily removed, when desired, by means of a spatula, the small portions remaining in the perforations being pushed out with the point of a needle.

I have repeatedly prepared these filters in the manner above described, and have filtered with them such preparations as freshly precipitated barium sulphate to my entire satisfaction. Not only that, but by treating the precipitates with their proper solvents I have been able to clean the felt so that the same filter could be used repeatedly. The following data illustrates such use of this filter:—

	Grms.
Weight of crucible and felt after first ignition..	31·0612
,, ,, ,, second ,, ..	31·0607
Weight of crucible and felt after rubbing with glass rod to remove thin spots..	31·0607
Weight of crucible and felt after third ignition..	31·0607
Weight of ditto after 250 c.m. of water have been passed through ten times..	31·0607
Weight of ditto after freshly precipitated CaC_2O_4 has been filtered upon it and ignited	31·5385
Weight of ditto after treatment with HCl, washing, and igniting..	31·0634
Weight of ditto after same operation repeated..	31·0609
,, ,, ,, ,, ,, ..	31·0608
Weight of ditto after $BaSO_4$ has been filtered upon it and ignited	31·4403

* *Proc. Am. Acad.*, 1878, p. 342.
† *Proc. Am. Acad.*, 1885, p. 390.
‡ *American Journal of Science*, vol. i., [3], May, 1871.

	Grms.
Weight of ditto after dissolving the $BaSO_4$ in hot concentrated H_2SO_4	31·0640
Weight of ditto after second treatment with H_2SO_4	31·0609
Weight of crucible complete..	30·6744
Weight of felt..	0·3863

Felts of this character may of course be obtained by similar means from easily decomposable salts of other metals than platinum, and such felts may be found to have useful applications.

It is probable that this method of producing a platinum sponge within a platinum tube may find useful applications in organic chemistry in addition to its use as a filter.—*Journal of Analytical Chemistry*, vol. ii., Part 3.

GEOMETRICAL ILLUSTRATIONS OF NEWLANDS' AND MENDELEEFF'S PERIODIC LAW OF THE ATOMIC WEIGHTS OF THE CHEMICAL ELEMENTS.*

By the Rev. SAMUEL HAUGHTON, M.D.

(Concluded from p. 95).

Part II.—The Third and Fourth Periods of Seven Elements Following Chlorine; or, the Titanium-Germanium Double Period.

I now proceed to the discussion of the third and fourth periods of seven elements each.

Third Period, or Titanium Period.

	Element.	Atomic Weight.	Valency.
1.	Potassium	39	Monad.
2.	Calcium	40	Dyad.
3.	Scandium*	44—45	Triad.
4.	Titanium.	48	Tetrad.
5.	Vanadium	51	Triad.
6.	Chromium	52	Dyad.
7.	Manganese	55	Monad.

Fourth Period, or Germanium Period.

	Element.	Atomic Weight.	Valency.
1.	Copper.	63	Monad.
2.	Zinc	65	Dyad.
3.	Gallium (*Ekaluminium*)..	69	Triad.
4.	Germanium (*Eka Silicium*)	72	Tetrad.
5.	Arsenic	75	Triad.
6.	Selenium	79	Dyad.
7.	Bromine	80	Monad.

At the commencement of the year 1875 there were three unknown elements of this table, viz.:—

Gallium, found in 1875;
Scandium, found in 1879;
Germanium, found in 1886.

And it is the glory of the Periodic Law of Modern Chemistry that it predicted (approximately) the atomic weights of these three unknown elements and their valencies, which predictions were fulfilled by the successive discovery of the unknown elements.

In Plate IV., which is a representation of the third and fourth periods of Dr Reynolds's curve, we can see that a triad element is wanting between calcium and titanium, and both a triad and tetrad element wanting between zinc and arsenic. These missing elements were predicted and found.

It is quite true that there were three well-known elements lying between manganese and copper, viz., iron, nickel, and cobalt; but these three elements did not conform to the rules of the Periodic Law, and their places have been taken in that law by scandium, gallium, and germanium.

They were like the "three children in the oven" described by Daniel (Shadrach, Meshach, and Abednego), who refused to worship the Golden Image or Periodic Law set up by Nebuchadnezzar and the modern chemists.

I hope to show in the present Paper that iron, nickel, and cobalt are not so refractory as they appear at first sight; but, on the contrary, ready to take their proper places on the chemical curve when rightly interpreted.

An inspection of Plate IV. shows (just as we found in the former curve in the case of the tetrad elements, carbon and silicon) that the line joining the tetrad elements, titanium and germanium, contains five elements, viz.:—

Ti | Va | Ca | Ga | Ge,

leaving nine elements free, which sit upon a general cubic—

K | Ca | Sc | Cr | Mn | Zn | As | Se | Br.

If we use the atomic weights and valencies of these nine elements (taking scandium=44·3), we can find the equation of the cubic passing through these points, the form of which I have plotted in Plate V., and which has one real asymptote like the former cubic, but has a much more complex shape.* The dyad lines, both positive and negative, have a remarkable relation to the cubic curve. They are both very near the position of the horizontal tangent.

In fact, the positive dyad line intersects the cubic in three real points, viz.:—

79, 65·064, 65.

The first of these is the element selenium, and the third the element zinc, with another element almost identical with zinc in atomic weight, both points being nearly on the horizontal tangent.

The negative dyad line intersects the cubic in three real points also, viz.:—

40, 52, 56;

which represent exactly the atomic weights of the three elements—calcium, chromium, and iron.

Now, we must remember that the cubic curve was constructed without any reference to iron or its atomic weight, and it is very remarkable to find it taking its place on the curve after chromium, and near nickel and cobalt, which are not far off the dyad line.

In fact, the cubic curve points out by clinging to the dyad line from 52 to 59, the possibility of forming in that interval a number of elements similar to each other in physical and chemical properties. These elements have been actually formed, and are—

Chromium, Iron, Nickel, Cobalt.

Excepting these four elements formed on the cubic branch of the curve, the distribution of the remaining elements between the lineal and cubic branches is similar to that found in the curve described in Part I.

The first three elements are on the cubic, viz.:—

K | Ca | Sc.

The last three elements are also on the cubic branch, viz.:—

As | Se | Br.

The central elements alternate as before between the lineal and cubic branches, viz.:—

Mn cubic,	Mn (*bis*) 57	lineal;
Cu lineal,	Cu (*bis*) 64	cubic;
Zn cubic,	Zn (*bis*) 66	lineal;

with a possibility of forming three other elements near them, which have not come into existence.

The remaining elements are formed in pairs on the

* Abstract of a Paper read before the Royal Irish Academy, May 14, 1888.

† The atomic weight of scandium lies between 44 and 45, but nearer to 44.

* I venture to call it a serpentine "whiplash" cubic.

Plate IV.

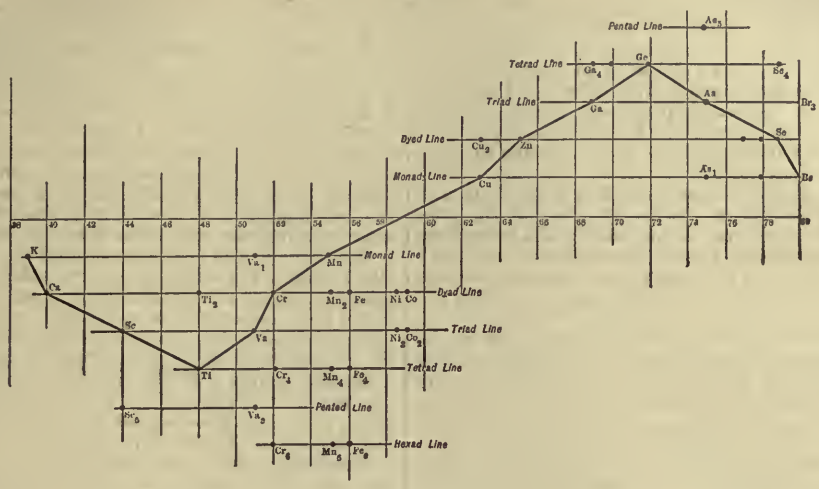
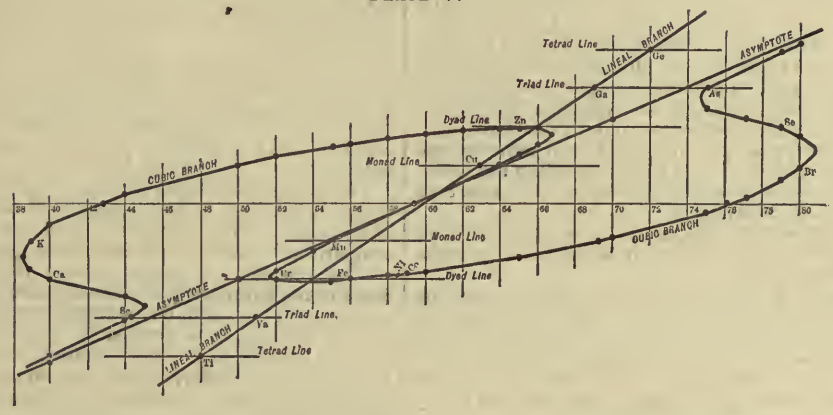


Plate V.



lineal branch in the two gaps of the cubic branch, where two roots become imaginary, viz.:—

Ti | Va,

with a possibility of another element of atomic weight 50, forming a monad on the cubic at the opposite side, and in the other gap—

Ga | Ge,

with the possibility of another monad element of atomic weight 69½ at the opposite side.

Note.

Table of Fourteen Elements, with Name of Discoverer and Date.

	Element.	Name.	Date.
16.	Potassium.	Davy.	1807
17.	Calcium.	Davy.	1808
18.	Scandium.	Nilson.	1879
19.	Titanium.	Gregor.	1789
20.	Vanadium.	Sefstrom.	1831
21.	Chromium.	Vanquelin.	1797
22.	Manganese.	Gahn.	1774
23.	Copper.	—	Prehistoric.
24.	Zinc.	Paracelsus.	xvi. century.
25.	Gallium.	De Boisbaudran.	1875
26.	Germanium.	Winkler.	1886
27.	Arsenic.	Brandt.	1733
28.	Selenium.	Berzelius.	1817
29.	Bromine.	Balard.	1826

Additional Isolated Elements.

	Element.	Name.	Date.
30.	Iron.	—	Prehistoric.
31.	Nickel.	Cronstedt.	1751
32.	Cobalt.	Brandt.	1735

ON THE

REDUCING ACTION OF HYDROGEN IN PRESENCE OF PLATINUM.

By STEPHEN COOKE.

Several years ago I made some experiments on the action of hydrogen on solutions likely to be reduced by this gas. With hydrogen alone, however, in most cases no action was observed. It then occurred to me that the action might be promoted by the presence of finely divided platinum; for although the action of this substance is so well known in bringing about the combination of gases with each other, it has not, as far as I am aware, been much used to bring about or accelerate the action between gases and liquids. Gladstone and Tribe (*Journ. Chem. Soc.*, xxxiii., 306, 1878) have shown that hydrogen occluded by finely divided metals is analogous to nascent hydrogen. The same conclusion may be drawn from the results of my own experiments, which were, however,

made in a somewhat different, manner, and were rather more extended than those of the above-mentioned chemists.

Most of my experiments were made in tubes closed at one end, and from 300 to 400 m.m. in length, and about 15 m.m. in diameter. A piece of platinum foil as long as the tube and of such a width as to pass freely into it, is placed in the tube, and kept in its place by a wire passing through the closed end, and projecting a few m.m. from it. The foil can be coated with platinum black by electrolysis, and the coating can be readily renewed without removing the foil by filling the tube with platinic chloride and connecting the wire passing through the sealed end with the zinc end of a battery; the other pole being a wire passing through a bit of small glass tube, and projecting a little from the closed end.

Platinum foil so prepared gradually loses its activity or power in bringing about combination. Between hydrogen and liquids this loss of activity for the most part merely results in a slower action, the *nature* of the change being the same. In the case of some gases, however, not only is the rate, but also the kind of the chemical change to some extent influence by the activity of the platinum; but this may be due to the higher temperature produced, and not to any increased activity of the occluded hydrogen.

The efficiency of the prepared platinum can be readily tested by transferring electrolytic gases to the tube. Perhaps one or two experiments may not be out of place. A freshly-prepared tube was rapidly filled with a mixture of electrolytic gases; there was a rapid contraction for five or six seconds, followed by an explosion. In a similar tube which had been in use some months the contraction was much slower, taking from ten to fifteen minutes, and there was no explosion. In a tube containing foil which had not been coated or specially cleaned, the gases took about thirty hours to disappear.

The hydrogen was in most cases made by the electrolysis of pure dilute sulphuric acid, but in some cases by dilute sulphuric acid and zinc.

The experiments were generally made by filling the tube with the solution under trial, then displacing the solution with hydrogen and leaving the filled tube standing in the solution. With corrosive liquids, instead of the tubes just described, a V tube may be used, one limb of which is closed, and contains the prepared foil.

Nitric Acid.

A number of experiments have been made on the reducing action of occluded hydrogen on nitric acid and other oxygen compounds of nitrogen, and as the action of this gas can be studied on each compound apart from the rest, and as hydrogen in this condition resembles in its action nascent hydrogen, the results may reasonably be expected to throw a little light on the difficult and complicated subject of the action of metals on nitric acid.

A tube of electrolytic hydrogen was kept over nitric acid (sp. gr., 1·42) for six weeks; there was not, however, the least sign of any absorption. Similar tubes were kept for several months over acid somewhat more diluted than this, but no contraction of the volume of gas was noted in any case. This, then, shows the remarkable difference between ordinary or molecular hydrogen and the same element in a nascent state—a difference generally attributed to different atomic aggregation.

Hydrogen in contact with prepared platinum foil acts very readily on nitric acid. With acid of sp. gr. 1·42 red fumes make their appearance almost immediately and attain their maximum in a few minutes; there is then a gradual contraction in the gas, which is not quite absorbed for an hour or two unless the tube be agitated. The acid has by this means acquired a yellow appearance, being evidently reduced to nitrous acid.

With acid more diluted than this the results are similar, but the fumes are less red, and with an acid weaker still no red fumes appear; the action, therefore, is between the hydrogen and vapour of nitric acid.

If the acid (1·42) be diluted with four or five times its volume of water it is still acted on by hydrogen pretty rapidly, the contraction being from 40 to 50 m.m. per hour, depending on the freshness of the platinum black; the resulting acid has a nitrous smell and a reducing action on potassium permanganate. More diluted still the action is slower, but still there is an action, the lower limit of which I did not determine. With normal acid, however, the action is exceedingly slow; in seven days the contraction was only 30 m.m. in one of my experiments; with one-half normal (the weakest acid used in this mode of experimenting) the action was much the same.

Heat will greatly accelerate the action of hydrogen on dilute acid. For this purpose the tube is filled to the extent of about three-fourths with hydrogen, and either sealed up or closed with a good cork; it must be tied and then placed in a slanting position, so as to expose as much foil as possible to the liquid and gas in the water-bath.

Heated in this way with normal acid the absorption was almost complete in two hours, the acid in the tube giving the reaction for nitrous acid and also indicating a little ammonia with Nessler's reagent.

With half normal acid treated in the same way the result was pretty much the same; less nitrous acid and more ammonia appeared to be produced. With one-eighth normal acid the action was slower, but by six hours' heating in the water-bath nearly all the hydrogen had disappeared.

With $\frac{1}{16}$, $\frac{1}{32}$, and $\frac{1}{64}$ normal acid the action was very similar; in from five to eight hours the hydrogen almost or quite disappeared, and the residue in the tube gave in every instance the reactions of nitrous acid and ammonia. No acid more dilute than $\frac{1}{64}$ normal was experimented with.

The action of occluded hydrogen on these dilute solutions of nitric acid is interesting, as showing the activity of hydrogen in this condition; and for the purpose of comparison I have sometimes made an electrolysis of acid of the same strength, using a very weak current. Some of the hydrogen under these conditions will reduce a portion of the acid, but another part of the hydrogen always appears in a free state at the negative pole, showing that the gas in this condition can with difficulty, and only incompletely, reduce acid so dilute, which acid is freely acted on by occluded hydrogen if assisted by a moderate heat.

Nitrates.

The nitrates are all reduced by occluded hydrogen, but the action is not quite so rapid as with some other solutions. Hydrogen standing over a saturated solution of potassium nitrate was absorbed to the extent of 25 c.c. in six days; the solution in the tube smelt of ammonia, and showed that a nitrite had been formed. With sodium nitrate the action was very similar. Hydrogen sealed up in a tube containing platinum with a strong solution of potassium nitrate acted much more rapidly on exposing it to the heat of the water-bath. The gas had almost disappeared in two and a half hours, and the solution had a strong smell of ammonia and gave a reaction for a nitrite.

Hydrogen standing in a similar tube without platinum over a concentrated solution of nitre, gave no contraction in one month; and a similar sealed tube exposed to the heat of 100° C. in a water-bath for some hours showed no signs of contraction.

Crumpled platinum foil coated with platinum black was placed in a flask and half covered with a solution of KNO_3; when the flask was filled with hydrogen and heated on a water-bath the solution showed in a few minutes an alkaline reaction, and there was an evolution of ammonia. Other nitrates are also reduced. Those of barium and calcium, for instance, are reduced gradually at ordinary temperatures, and much more rapidly at the temperature of boiling water.

Cobalt Nitrate.—Hydrogen (without platinum) stood over a strong solution of cobalt nitrate for some weeks; but there were no signs of absorption. In the presence

of coated platinum, however, there was a gradual but slow contraction of the gas. In a week this amounted to a column 150 m.m. in height; on the foil there were a few spots of a greenish-blue colour, and a brownish-yellow flocculent matter deposited. Some of the same solution was sealed up in a tube with hydrogen and heated for one hour (in presence of platinum); at the end of that time all the hydrogen had disappeared.

Nickel Nitrate.—This compound behaves in a similar manner, being slowly acted on at ordinary temperatures, and by two hours' heating in the water-bath the action is complete. No action occurs without the platinum.

Lead Nitrate.—When treated in the same manner this body gave similar results; without the presence of platinum it gave no result, either hot or at ordinary temperatures.

Copper Nitrate.—Russell (*Journ. Chem. Soc.*, xxvii., 3, 1874) states that copper nitrate and some other substances appear to be reduced by hydrogen; no particulars of of experiments are, however, recorded. I have kept hydrogen standing over a strong solution of this salt for some weeks without any obvious result; in the presence of platinum, however, the hydrogen is readily absorbed with a production of copper nitrite, apparently. (In one of my experiments a slight deposit of metallic copper seemed to be formed on the platinum foil, but this is not always the case). *Nitrates of mercury* and *bismuth* are acted on by occluded hydrogen.

Silver Nitrate.—Chemists are by no means unanimous as to the action of hydrogen on silver nitrate. A diluted solution of this salt is readily reduced by occluded hydrogen to a metallic state, small brilliant-looking crystals making their appearance on the foil. The action with platinum was about ten times as rapid as without, with a dilute solution; with a concentrated one the difference is not so marked. I did not see any reduction to nitrite mentioned by Russell in the paper above alluded to, but the reduction did not, I expect, go far enough to produce this salt.

From these experiments it appears that all nitrates are readily reduced by occluded hydrogen.

Chlorine, Bromine, and Iodine.

Chlorine in the dark does not, as is well known, combine with hydrogen. I kept a tube of hydrogen standing over chlorine water for seven days, but there was not the slightest contraction. In the presence of platinum, however, the contraction is at the rate of 50 or 60 m.m. per hour; but with chlorine and bromine the finely-divided platinum is liable to become detached from the foil, and hence the action, after a time, becomes slower.

Hypochlorous acid is reduced by hydrogen under the usual conditions of experiment.

Hydrogen standing over a saturated solution of $KClO_3$ showed no contraction in six weeks. In the presence of the prepared foil the action is fairly rapid, being at the rate of 10 m.m. per hour. The chlorate is reduced to chloride; a quantitative experiment accounted for all the hydrogen absorbed.

Potassium perchlorate is not acted on.

Bromine water acts pretty much the same as chlorine. Iodine in a solution of potassium iodide is acted on more slowly.

Bromates and iodates were not experimented with.

Concentrated Sulphuric Acid.

It is sometimes stated in text-books that hydrogen attacks concentrated sulphuric acid; *e.g.*, in Frankland's and Japp's "Inorganic Chemistry" the following note occurs:—"The use of concentrated sulphuric acid as a desiccating agent ought to be avoided if a very pure gas (hydrogen) is required, as hydrogen slowly reduces this acid in the cold, with formation of sulphurous anhydride." In order to test this, I kept pure hydrogen over pure concentrated sulphuric acid for three weeks. There was no sign of contraction, and the acid had no smell of SO_2, and not the least reducing action on potassium permanganate. The reducing action of hydrogen on this acid must therefore be extremely small to exhibit no action in three weeks, and I cannot help thinking that one might safely dry hydrogen by means of sulphuric acid, provided the gas be pure; should it contain sulphuretted or phosphoretted hydrogen it would be quite another matter.

In contact with prepared foil the action is very different. There is a steady but slow absorption, which amounted to 150 m.m. in three days. The acid, when examined, smelt strongly of SO_2, and had a reducing action on potassium permanganate.

Hydrogen reduces H_2SO_3, but the action is slow.

Permanganates.

Potassium permanganate is slowly reduced by hydrogen, but the action is very slow; in the presence of platinum it is much hastened; but even in this case it is slower than one would have expected, the upper surface of the foil soon becoming exhausted unless agitated.

Bichromates.

An acidulated solution of potassic bichromate was not reduced by hydrogen in six weeks without platinum; with platinum the action is steady and fairly rapid.

Ferric Salts.

Ferric salts are not reduced by prolonged contact with hydrogen. In presence of platinum ferric chloride is readily reduced, and the reduction proceeds with great regularity; if the platinum deposit be fresh the contraction will amount to 50 or 60 m.m. per hour. The greater regularity shown in the reduction of this salt, compared with some others, is owing no doubt to its solubility, thus preventing the upper layer from becoming exhausted.

Ferric sulphate is very readily reduced by hydrogen in presence of platinum. In my experiment the action seemed a little more rapid than with the chloride.

Warren (Chemical News, vol. lv., p. 49) has suggested the use of ferric salts instead of potassium bichromate as a fluid for the galvanic battery. I know nothing of its efficiency for that purpose, but in my experiments a concentrated solution was more readily reduced than the acidified bichromate.

Mercuric Salts.

Mercuric chloride was not reduced by hydrogen alone in six months. With platinum it rose 75 m.m. in twelve hours, and a crust of white powder (Hg_2Cl_2) coated the foil. After a time the action became much slower from exhaustion of the upper layer.

Platinum Salts.

Platinum chloride is slowly reduced by hydrogen alone in the cold. The presence of the prepared foil greatly accelerates the action, which is as great in one hour with the foil as in forty-eight hours without it. The upper layer is completely reduced, becoming quite colourless.

Ferricyanides.

Hydrogen standing over potassium ferricyanide was reduced by 15 m.m. in twelve months; with the foil it is pretty readily reduced to ferrocyanide.

Action of Hydrogen on Nitric Oxide in Presence of Platinum.

Although this paper deals chiefly with the reducing action of hydrogen, it may not be out of place to mention here a few experiments with nitric oxide and hydrogen. The subject is by no means a new one. Most chemical works record the fact that hydrogen and nitric oxide give rise to ammonia when led over gently-warmed spongy platinum, and the reducing action of nascent hydrogen on the same gas is employed in preparing hydroxylamine. The method I have adopted in studying the reducing

action of hydrogen seemed suited also to investigate the action of gases on each other, inasmuch as the residual gases can be readily measured and examined. I have made a great number of experiments with these gases, and some of the results seem worth recording.

The experiments were, for the most part, made in the same tubes I have already described, some experiments on a much larger scale. In some cases the experiments were made over mercury, generally over water. One volume of hydrogen and two volumes of nitric oxide standing over mercury gave a very regular action, and the results of the different experiments were constant and represented by the equation $2NO + H_2 = N_2O + H_2O$. (Although standing over mercury the gases were moist, as the tube was first filled with water, over which the mixed gases were collected. If the tube had been filled with mercury the finely-divided platinum would have amalgamated with the mercury and so lost its activity.) Equal volumes of nitric oxide and hydrogen, treated in the same way, gave a contraction equal to one-half the original volume, the residue being nitrogen.

Made over water, the results are pretty much the same; on the whole they are, perhaps, a little less regular, due, no doubt, to the solution of a little of the nitrous oxide in the water.

With a larger proportion of hydrogen the action is much more rapid, taking place in the course of a few minutes if the platinum is pretty active, and leaving a strongly alkaline residue. Similar experiments made on a larger scale gave very interesting results.

Hydrogen to the extent of 600 c.c. was collected in a cylinder, in the upper part of which a large piece of platinum foil was placed; 150 c.c. of nitric acid were added rapidly. There was an almost immediate action—first the water in the cylinder was somewhat depressed, and heavy whitish fumes appeared near the foil: there was then a pretty rapid contraction of the gas, till only 300 c.c. remained, 450 c.c. having disappeared. This action only took a few minutes, and considerable heat was developed during the change. The residue was chiefly hydrogen, but it contained a little nitrogen; all the nitric oxide had disappeared, and there was no nitrous oxide in the residue. The liquid was strongly alkaline, and gave the reaction for hydroxylamine.

Similar experiments have been made with like results, and the contraction is very often the same as the above, though sometimes it may be a little less.

Ammonia is formed at the same time, and the change might be represented as follows:—

$$2NO+8H=NH_3O+NH_4HO.$$

This, however, does not account for the small amount of nitrogen resulting from the experiment. This is a very interesting reaction, but by no means an unexpected one, seeing that hydroxylamine is prepared by the action of nascent hydrogen on nitric oxide.

If the nitric oxide is added in a much smaller proportion than was used in the last-mentioned experiment (viz., 1 to 4 hydrogen) the action appears pretty much the same, but much slower; for instance, I added to 600 c.c. of hydrogen 50 c.c. of NO, and the action was not complete for one hour, when 150 c.c. had been absorbed; on adding another 50 c.c. a similar contraction takes place. After a time, however, the contraction is less than that just indicated.

These experiments show the influence of mass in determining chemical change. With a small amount of hydrogen the reduction is to nitrogen and nitrous oxide; when the hydrogen is greater in amount, ammonia and hydroxylamine are the chief products of the reaction.

As in these experiments the nature of the change depends largely on the mass of gases present, I tried the effect of the copper-zinc couple on nitric oxide by placing a piece of zinc in a tube, coating it with copper, and then filling the tube with nitric oxide. The action is not very rapid, and the gas left is from one-fourth to one-third of the nitric oxide taken; ammonia and a little hydroxylamine are formed.

In this case, therefore, the hydrogen is to some extent capable of uniting with the nitrogen, but not nearly to the extent that it does when there is a large mass of hydrogen in presence of platinum.

In presence of platinum, nitric oxide is reduced by carbonic oxide, forming nitrous oxide or nitrogen, according to the quantity of CO present.

Nitric oxide is also reduced by ammonia in presence of platinum. Nitrous oxide is reduced by hydrogen, ammonia, and carbonic oxide in presence of platinum.

In a few experiments, when nitric oxide was mixed with the smaller proportions of hydrogen mentioned, there were slight indications of hyponitrous acid; in other cases, however, no trace of this body could be obtained. If this substance is formed, I believe its formation depends on the activity of the platinum.

These experiments may be considered as proving that hydrogen, in presence of finely divided platinum, possesses all the properties of nascent hydrogen. In many cases the action is slow, but in some it might perhaps be used as a means of reduction when the presence of sodium-amalgam or the copper-zinc couple is objectionable.—*Glasgow Philosophical Transactions.*

ON A METEORIC IRON FOUND IN 1884 IN THE SUB-DISTRICT OF YOUNDEGIN, WESTERN AUSTRALIA, AND CONTAINING CLIFTONITE, A CUBIC FORM OF GRAPHITIC CARBON.

By L. FLETCHER, M.A., F.C.S.,
President of the Mineralogical Society.

This iron was found on January 5, 1884, by Alfred Eaton, a mounted police constable, when on duty in the sub-district of Youndegin, at a spot distant about 60 chains (three-quarters of a mile) in a north-west direction from the top of Penkarring Rock, and roughly estimated by him at 70 miles east of York, Western Australia; this must be about longitude 117° 30′ E. of Greenwich, latitude 31° 30′ S. Only one of four observed fragments having been brought in by Mr. Eaton, the late Captain Smith, Commissioner of the Police at Perth, sent him out to Penkarring with a native assistant with instructions to bring in the other three, at the instance of the Rev. Charles G. Nicolay, Curator of the Geological Museum, Freemantle, to whom the late Mr. Edward T. Hardman, F.C.S., the Government Geologist, had expressed his belief in the meteoric origin of the iron. Eaton and his companion started off on horseback at 8 a.m. on February 28, encamped at a "rock hole" for the night, and, leaving at 6 a.m. the next day, reached Penkarring at 7.30 a.m. An unsuccessful search was made for fragments additional to those already observed. Leaving Penkarring at 7 a.m. on March 1, they encamped at Morecanning for the night, and arrived at York Police-station at 7 o'clock on the following morning.

To the zeal and thoughtfulness of Mr. Nicolay we are indebted for the preservation of the specimens, and for the particulars of their discovery; by him, at the suggestion of Lady Barker, the largest and the smallest fragments have been generously presented to the British Museum through Mr. R. H. Scott, F.R.S., as Secretary of the Mineralogical Society.

The four fragments were lying loose on the surface, three of them close together, and the fourth about 15 ft. away; they weighed 25¾ lbs., 24 lbs., 17½ lbs., and 6 lbs. respectively; in the opinion of Mr. Nicolay they seem to have formed a portion of a spherical mass, although they are individually irregular in shape. Scattered around the iron there were broken pieces, apparently belonging to a shell or outer covering, and of these a weight of 17

lbs. was collected. As the latter fragments consist essentially of magnetic oxide of iron, they are doubtless due to the action of the weather on the meteorite; the samples sent to the Museum have a laminated structure, and one of them is an inch in thickness.

The country around Youndegin is described as granitic, with dykes of quartz, and schistose rocks; there is a superficial covering of sandstone, in which, though widely distributed over the Colony, no fossils have yet been found; there is no appearance of iron ore at Youndegin, though, in many parts of the Colony, iron ores are found in abundance. The above circumstances indicate an extra-terrestrial origin for the iron.

The only meteoric iron previously discovered in Australia is that of Cranbourne, near Melbourne, 1500 miles distant from Youndegin.

The largest of the two fragments presented to the British Museum weighed 25¾ lbs.; it is 12 inches long, 10 inches broad, and has a maximum thickness of 3 inches. In shape it is rudely convex at one side and concave at the other; its surface presents numerous spherical depressions. It is distinguished from all the meteoric irons in the British Museum collection by two cylindrical holes, completely traversing the iron from back to front; one of them has a diameter varying from 2 to 2¼ inches, and a length of 1½ inches; the other is of nearly the same size; three similar annular openings characterise the iron of Tazewell, Claiborne County, Tennessee, U.S.A., described and figured by the late Professor Lawrence Smith.* The large Signet iron, preserved in the National Museum at Washington, is an almost complete ring†; the meteoric iron of Independence County, described lately by Mr. Hidden,‡ is likewise remarkable for the presence of a small hole.

The smallest fragment of the Youndegin iron, weighing 6 lbs., also in the British Museum, is likewise concavo-convex, but is without holes: it is 7 inches long, 4½ inches broad, and about 2 inches thick.

The fragment weighing 24 lbs. is similar to the last mentioned; it is 9¾ inches long, 6 inches broad, and 4 inches thick: it is to be preserved in the Geological Museum, Freemantle.

The remaining fragment weighing 17½ lbs. has been presented to the Melbourne Museum, Victoria.

The specific gravity was determined from three small pieces of the larger fragment, freed from rust; the numbers obtained were 7·86, 7·85, and 7·72 respectively.

The large specimen was cut on the premises of the Museum by means of hack-saws, and was found to be so hard that three weeks were required for the severance of a fragment of which the cut face is not 2½ inches square; a larger section of another meteoric iron (Nejed) was made in one-third of this time. The surface was next worked down with hard files of increasing fineness, and lastly polished with felt and emery powder.

On this face are seen numerous sections of enclosures, mostly tabular, of a yellowish metallic mineral which is strongly attracted by a magnet; this was found to be Schreibersite (phosphide of iron and nickel); some of the enclosures are in parallelism, and parts, isolated on the surface of the iron, are lineally arranged; the edges of the plates are only approximately straight; starting from them, thin cracks containing Schreibersite traverse the surface of the section in irregular directions; one of the plates is an inch long and one-eighth of an inch thick.

No stony matter is visible on the polished surface.

Relative to copper sulphate the iron is almost immediately active.

After exposure to the action of bromine water or dilute nitric acid the section gives no definite figures, but assumes a damascene appearance, very like that of the Tucuman iron, and of some parts of that of Brazos; to the latter iron it is very similar in the proportion and distribution of the Schreibersite: the British Museum sections of the Arva and Sarepta irons are also, in parts, somewhat similar to it in their general characters.

On warming a fragment weighing 7 grms., in dilute hydrochloric acid, the greater part dissolved, and there was left a small residue (56 milligrms.) of yellowish metallic scales which are very strongly attracted by a magnet and contain phosphorus; they are doubtless Schreibersite, and identical with the enclosures visible on the polished surface.

None of the cubic crystals, described below, were present in this residue.

No sulphuretted hydrogen was detected in the gas evolved during the solution of the iron; this indicates the absence of troilite from the fragment under examination.

The sulphur precipitated on passing sulphuretted hydrogen into the solution was faintly brown; the colouration was found to be due to traces of copper, the constancy of which as an ingredient of meteoric iron has been insisted upon by Lawrence Smith.

Besides iron, only nickel, cobalt, and magnesium were found in the solution.

As the iron was too hard for its filings to be used as material for quantitative analysis, a large fragment, containing visible Schriebersite, was filed until free from rust; its weight was 8 3200 grms.; its specific gravity, at 14°·5 C., relative to water at 4° and allowing for displaced air, was 7·851 (uncorrected 7·86).

The fragment was dissolved in aqua regia in a porcelain dish, and evaporated to dryness, on the water bath; the residue was treated with strong hydrochloric acid, and again brought to dryness to expel the remaining traces of nitric acid; on warming with water containing some hydrochloric acid, it was found that there was a small insoluble residue, consisting wholly of minute bright opaque greyish black cubic crystals with metallic lustre. The solution itself was poured into a weighed double filter,* and the crystals were washed by decantation, the washings being passed through the double filter; the filter showed no change of weight. The weight of the crystals was found to be 3·1 milligrms.

The filtrate was made up to 1000 c.c., and portions, 125 c.c. each, were removed by means of pipettes.

In one portion sulphuric acid was sought for, but not a trace was found, indicating the absence of troilite from this fragment also.

Another portion was evaporated to dryness on the water-bath, and afterwards heated in an air-bath for three quarters of an hour, at a temperature of 140°—145° C.; no silica was obtained. The phosphoric acid in this portion was next concentrated in the manner recommended by Lawrence Smith,† precipitated as phospho-molybdate,‡ dissolved in ammonia, and weighed as magnesium pyrophosphate.

From a third portion the iron was separated by a double precipitation with sodium acetate, re-dissolved in hydrochloric acid, and re-precipitated with ammonia.§ After ignition it was reduced by heating in a current of hydrogen, and dissolved in dilute hydrochloric acid: in experiments on different portions variable minute quantities of silica were at this point obtained, and were derived probably from the reagents.

The nickel and cobalt were separated from the magnesium by ammonium sulphide, and weighed together both in the oxidised and metallic condition; after solution of the nickel and cobalt the latter was precipitated by potassium nitrite, and weighed as potassium cobalt sulphate.

(To be continued).

* *Amer. Journ. Sci.*, 1855, Ser. 2, vol. xix., p. 154.
† *Ibid.*, p. 161.
‡ *School of Mines Quarterly*, vol. vii, No. 2, Jan., 1886.

* "Original Researches," by Lawrence Smith, 1884, p. 312.
† *Am. Journ. Sci.*, 1882, Ser. 3, vol. xxiii., p. 316.
‡ Crookes's "Select Methods in Chemical Analysis," 2nd edition p. 517.
§ *Ibid.*, p. 272.

CORRESPONDENCE.

DR. PETERS'S AMERICAN METHODS OF COPPER SMELTING.

To the Editor of the Chemical News.

Sir,—In the Chemical News (vol. lviii., p. 76) Mr. J. W. Westmoreland takes to task the able writer of the above valuable work—

1st. For saying that the Cornish system of fire assay "is so interwoven with the commercial customs of the Swansea Copper smelters, and its replacement by one of the more accurate wet methods would involve such a revolution in the price lists and methods of ore buying, that it is likely to maintain its sway in the great market of the world for an indefinite time."

2nd. For speaking approvingly of the electrolytic assay of copper.

3rd. For omitting to mention Brown's iodide process for determining copper.

With your kind permission I would like to make some remarks on Mr. Westmoreland's criticism.

1st. Dr. Peters's book has for its subject *American* methods of smelting, &c., and is intended primarily for American readers, and since the Cornish system of dry assay has obtained no foothold in the United States, a minute treatment of the subject was not called for, and Dr. Peters's mention of this assay is obviously entirely incidental and cursory. Nevertheless, it is difficult to see wherein the Doctor has erred. It is still true, as when Dr. Peters wrote his book, that the dry assay is, in England, interwoven with the customs of the copper trade; and the abolition of Swansea ticketings is simply a portion of the revolution referred to by him. But for the present the dry assay is still the basis on which copper-bearing materials are valued. How long this will continue it is—as Mr. Westmoreland admits—difficult to say, and Dr. Peters exercised a wise caution in saying the dry assay was "likely to maintain its sway for an *indefinite* time." It is only by an unwarranted extension of the meaning of the word "indefinite" that the slightest justification for criticism appears.

2nd. The electrolytic process has been largely used in the United States for the valuation of copper ores, &c., for a number of years. This, in itself, constitutes strong evidence in its favour, for American analysts and metallurgists possess, in full measure, the shrewdness and ability for which their nation is famous. But Mr. Westmoreland himself has borne very strong testimony to the value of the electrolytic process. In the early part of a paper in the *Journal of the Society of Chemical Industry* (vol. v., p. 49) he says:—"The processes I personally employ in the examination of all copper ores and products are E. O. Brown's iodide process, and the electro-deposition method." And, at that time, so great was his faith in this process that he took the results obtained by it as the standard by which he claimed to prove the accuracy of the iodide process. At page 55 of the same *Journal* he gives comparative assays ("taken from a large number") of 28 samples of ores, mattes, and precipitates, the produce of which varied from as low as 0·45 to as high as 86 per cent. The maximum difference between the iodide mean tests, which Mr. Westmoreland so highly commends, and the electrolytic mean tests which he *now* so strongly condemns, was 0·23, and this was in one instance only, with 28 per cent ore; whilst the next greatest difference—in one case only—was 0·19; and after these two the greatest difference was 0·12, the average difference for the remaining 26 assays (including this 0·12) being only 0·034.

3rd. But Mr. Westmoreland's gravest charge is, that Dr. Peters omits to mention the iodide test. Now, the iodide process has been known for many years, but until quite recently was believed to have only a limited application, and was very little used in the assay of copper ores, &c. Mr. Westmoreland, in the paper above referred to (written in February, 1886), says:—"*One or two* analysts in this country use the iodide process. Since that date the number of analysts who have adopted the process has doubtless increased, but even yet the process cannot, by the greatest stretch of language, be said to be in common use; and as Dr. Peters's book is essentially a practical work on the metallurgy of copper, and not a text-book of analytical chemistry, his omission to mention what was, at the time he wrote, a discarded process, is quite justifiable. When the time comes for revising the work for another edition, and if the iodide process shall, in the meanwhile, have taken the position which Mr. Westmoreland (perhaps justly) believes its merits entitle it to, it will then be soon enough for Dr. Peters to take cognisance of this very interesting method of assaying.

On the general question of assaying and valuation of copper-bearing materials, on which Mr. Westmoreland has so ably written, I have no desire to enter further than to express the opinion that his latest dissertation might just as well have been written to another text.—I am, &c.,

W. M.

Newcastle-on-Tyne,
August 24, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 7, August 13, 1888.

On Amorphous Antimony.—F. Hérard.—The author has obtained the allotropic modification of antimony, signalised by M. Gore, and resulting from the decomposition of antimony chloride, bromide, or iodide by the battery. He heated antimony to dull redness in a current of nitrogen, and observed a development of greyish vapours, which condensed in a grey powder on the sides of the glass tube in which the apparatus terminates. This powder consists of minute globules united together like the amorphous arsenic of Bettendorff; it contains 98·7 per cent of antimony. Its specific gravity at 0° is 6·22, that of crystalline antimony varying, according to Isidore Pierre, from 6·725 to 6·737. Amorphous antimony melts at 614°, whilst crystalline antimony melts at 440°. The author suggests that there is first formed an antimony nitride, which is decomposed in the cooler portions of the tube, depositing amorphous antimony.

Four New Zinc Titanates.—Lucien Levy.—The author has obtained these titanates by melting titanic acid with mixtures of zinc and potassium sulphates. The essential points are the temperature and the quantity of the flux. At dull redness the product is always the sesquibasic titanate. At bright redness it is one of the three others, and the nature of the product depends on the proportion between the weight of the flux and the weight of zinc sulphate.

Zeitschrift fur Analytische Chemie. Vol. xxvii., Part 2.

Determination of Phosphoric Acid in Basic Slags. C. Brunnemann (*Chemiker Zeitung*).—The author digests 10 grms. slag with 30 to 50 c.c. of water in a beaker holding 400 to 500 c.c.; 80 to 100 c.c. of strong hydrochloric acid are added, 50 c.c. of nitric acid, and lastly 10 c.c. of strong sulphuric acid, and the liquid is boiled

for thirty to forty-five minutes. The hot liquid is then poured into a litre flask containing about 400 c.c. of hot water, and the beaker is rinsed out with hot water. The solution is diluted to about 900 c.c. to dissolve any calcium sulphate which has separated out, let cool, filled up to the mark and let settle; 50 c.c. of the clear liquid are then taken and evaporated on the water-bath until the excess of nitric and hydrochloric acid is expelled. The free sulphuric acid is cautiously neutralised with dilute ammonia until the residue in the capsule takes a brown colour. It is now evaporated to dryness, heated in the air-bath for half an hour to 110° to separate silica, 10 c.c. strong nitric acid are poured upon the residue, stirring well with a glass rod, 40 to 50 c.c. of boiling water are added; the liquid is filtered, the filter washed, and in the solution the phosphoric acid is determined by the molybdenum method. This method determines both the phosphorus present as phosphoric acid and that existing as phosphide, which Kennepohl considers to be very trifling. He therefore recommends the following process:—10 grms. slag are placed in a 500 c.c. flask, moistened with alcohol, 40 c.c. of hydrochloric acid of sp. gr. 1·12, and an equal volume of water, and the whole is heated in the water bath for at least half an hour. When cold the flask is filled up to the mark, the liquid is filtered, and 25 c.c. of the filtrate are taken without previous elimination of silica mixed with ammonia and molybdenum mixture, heated for fifteen minutes to about 80°, filtered when cold; the precipitate, washed with cold water containing a little nitric acid, dissolved in cold ammonia at 2½ per cent, and precipitated with magnesia mixture.

Examination of the Artificial Colours Occurring in Trade.—E. Weingaertner.—A very valuable paper, but one incapable of abridgment, and too extensive for insertion in full. It treats of the colours insoluble in water, and of those which are sold in the state of pastes.

Determination of Lead in Tin Alloys.—G. Schwartz (*Chemiker Zeitung*).—One grm. of the alloy is rolled out as fine as possible, covered with 20 c.c. of strong hydrochloric acid and heated gently. As a rule, in half an hour the alloy is dissolved, leaving the antimony behind. To dissolve the latter bromine water is added until the liquid becomes yellow, the excess of bromine is expelled by boiling, the liquid diluted to 100 c.c., let cool, and poured, shaking it round, in a thin stream into a solution of 40 grms. commercial crystalline sodium sulphide in 150 c.c. water. After the lead sulphide has subsided the supernatant liquid is poured through a filter and the precipitate is washed with dilute ammonium sulphide (1 vol. ammonium sulphide prepared with 10 per cent ammonia and 9 vols. water). The filter and precipitate are put in a porcelain capsule, covered with a funnel, treated with a 10 c.c. nitric acid of sp. gr. 1·5, and as soon as the first violent reaction is over 5 c.c. of strong sulphuric acid. It is then warmed upon asbestos paste-board with a small flame, or until the contents of the capsule have become colourless or pale brownish, let cool, the funnel is spirted out with alcohol at 50 per cent, diluted therewith to 100 c.c., washed as usual, ignited, and weighed. The lead sulphate, after washing, is treated with basic ammonium tartrate, which dissolves everything except traces of lead oxide, which are collected and deducted.

The Examination of Extracts.—A. Kremel.—Instructions for ascertaining the purity of extracts of pomegranate bark, ratanhia, quassia, rhubarb, aconite, &c.

Detection of Sugar in Urine.—Marson.—The author adds to 8 c.c. of the sample 0·1 grm. ferrous sulphate, heats, adds 0·25 grm. potassa, and goes on heating for some minutes. If sugar is present the precipitate varies from dark green to black, and the supernatant liquid is more or less coloured. In a normal sample the precipitate is a greenish brown and the supernatant liquid is colourless.

Polarimetric Determination of Glycogen.—A. Cramer.—The author considers this method, as recommended by Külz, scarcely inferior to Brücke's gravimetric determination.

Pettenkofer's Reaction for Biliary Acids.—The colouration depends on the formation of furfurol.

Titration of Phosphoric Acid in Urine with Uranium Solution.—J. Mercier.—The author considers that this process, as given by Malot, may be advantageously used if decoction of cochineal is employed as an indicator.

Detection of the Indican of Urine.—Michailow.—The disturbing influence of urobiline may be eliminated by acidulating, saturating with ammonium sulphate, extracting urobiline and its chromogenes by means of acetic ether, then adding hydrochloric acid and chloroform, and oxidising with weak bromine-water.

Relations of Colouring-matters pre-existing in Urine to the Humic Bodies.—L. von Udránszky.—The author does not indicate any analytical method based upon the reaction which he brings forward.

Atomic Weight of Oxygen.—E. H. Keiser.—The author obtains the value 15·872.

Atomic Weights of Silver and Copper.—W. N. Shaw.—From the *Philosophical Magazine.*

Atomic Weights of Cobalt and Nickel.—Clemens Zimmermann (completed by Alibegoff and Krüss).—The atomic weight of cobalt is 58·74 (O=15·96) or 58·89 (O=58·89). The atomic weight of nickel is 58·56 (O=15·96) or 58·705 if O=16.

Re-determination of the Atomic Weight of Tungsten.—J. Waddel.—From the *American Chemical Journal*, reproduced in the Chemical News.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Estimating Aluminium with Sodium Thiosulphate.—Would any chemist kindly oblige me with his experiences as to the manipulation of Chancel's or Wöhler's method of estimating aluminium by means of sodium thiosulphate? We rarely obtain more than 40 per cent of the metal as oxide, the filtrate yielding the remainder on the addition of ammonia; nor have we been able to boil off the SO_2 in a few minutes, for the evolution of this gas continues as long as the solution is boiled. Chancel's equation in the *Comptes Rendus* is—$Al_2(SO_4)_3 + 3Na_2S_2O_3 = Al_2O_3 + 1\frac{1}{2}S_2 + 3SO_2 + 3Na_2SO_4$.—C. A Warren.

NOTICE.

The STUDENTS' NUMBER of the Chemical News *will be published on Friday, September 21st. Gentlemen holding official positions in the Universities, Medical Schools, &c., of the United Kingdom, where Chemistry and Physical Science form a part of the education, who have not yet forwarded the necessary information to our Office for publication in that Number, will confer a favour by sending it with the least possible delay.*

Advertisements for this Number should reach the Office not later than Wednesday, the 19th prox.

ST. PAUL'S SCHOOL.—An Examination for filling up about Eighteen Vacancies on the Foundation will be held on the 12th September next.—For information apply to the Bursar, St. Paul's School, West Kensington.

ST. PAUL'S SCHOOL, West Kensington.

Candidates for Foundation Scholarships are particularly requested to notice that the date of the Examination has been postponed from September 5 to September 12 and following days.

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The SESSION 1888-89 will commence on Monday, October 1st, 1888. The new buildings which were opened by T.R.H. the Prince and Princess of Wales, on May 21st, 1887, afford more than double the accommodation which was provided formerly

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1502.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Bath Meeting, September 5, 1888.

INAUGURAL ADDRESS OF THE PRESIDENT,

Sir Frederick Bramwell, D.C.L., F.R.S., M.Inst.C.E.

The late Lord Iddesleigh delighted an audience for a whole evening by an address on "Nothing." Would that I had his talents and could discourse to you as charmingly as he did to his audience, but I dare not try to talk about "Nothing." I do, however, propose, as one of the two sections of my Address, to discourse to you on the importance of the "Next-to-Nothing." The other section is far removed from this microscopic quantity, as it will embrace the "Eulogy of the Civil Engineer" and will point out the value to science of his works."

I do not intend to follow any system in dealing with these two sections. I shall not even do as Mr. Dick, in "David Copperfield," did—have two papers—to one of which it was suggested he should confine his Memorial and his observations as to King Charles's head. The result is, you will find, that the importance of the next-to-nothing and the laudation of the Civil Engineer will be mixed up in the most illogical and haphazard way throughout my Address. I will leave to such of you as are of orderly minds, the task of re-arranging the subjects as you see fit, but I trust—arrangement or no arrangement—that by the time I have brought my Address to a conclusion I shall have convinced you that there is no man who more thoroughly appreciates the high importance of the "next-to-nothing" than the Civil Engineer of the present day, the object of my eulogy this evening.

If I may be allowed to express the scheme of this Address in modern musical language I will say that the "next-to-nothing" "motive" will commonly usher in the "praise-song" of the Civil Engineer; and it seems to me will do this very fitly, for in many cases it is by the patient and discriminating attention paid to the effect of the "next-to-nothing" that the Civil Engineer of the present day has achieved some of the labours of which I now wish to speak to you.

An Association for the Advancement of Science is necessarily one of such broad scope in its objects, and is so thoroughly catholic as regards Science, that the only possible way in which it can carry out those objects at all is to segregate its members into various subsidiary bodies or sections engaged on particular branches of Science. Even when this division is resorted to it is a hardy thing to say that every conceivable scientific subject can be dealt with by the eight Sections of the British Association. Nevertheless, as we know, for fifty-seven years the Association has carried on its labours under Sections, and has earned the right to say that it has done good service to all branches of Science.

Composed, as the Association is, of a union of separate Sections, it is only right and according to the fitness of things that, as time goes on, your Presidents should be selected in some sort of rotation from the various Sections. This year it was felt by the Council and the Members that the time had once more arrived when Section G—the Mechanical Section—might put forward its claim to be represented in the Presidency; the last time on which a purely engineering Member filled the chair having been at Bristol in 1875, when that position was occupied by Sir John Hawkshaw. It is true that at Southampton in 1882 our lamented friend Sir William Siemens was President, and it is also true that he was a most thorough engineer and representative of Section G; but all who knew his great scientific attainments will probably agree that, on that occasion, it was rather the Physical Section A which was represented, than the Mechanical Section G.

I am aware, it is said, Section G does not contribute much to pure Science by original research, but that it devotes itself more to the application of Science. There may be some foundation for this assertion, but I cannot refrain from the observation that when Engineers, such as Siemens, Rankine, Sir William Thomson, Fairbairn, or Armstrong, make a scientific discovery, Section A says it is made, not in the capacity of an Engineer, and therefore does not appertain to Section G, but in the capacity of a physicist, and therefore appertains to Section A—an illustration of the danger of a man's filling two positions, of which the composite Prince-Bishop is the well-known type. But I am not careful to labour this point or even to dispute that Section G does not do much for *original* research. I don't agree it is a fact, but, for the purposes of this evening, I will concede it to be so. But what then? This Association is for the "Advancement of Science"—the *Advancement* be it remembered; and I wish to point out to you, and I trust I shall succeed in establishing, that for the *Advancement* of Science it is absolutely necessary there should be the *Application* of Science, and that, therefore, the Section, which as much as any other (or, to state the fact more truly, which more than any other) in the Association *applies* Science, is doing a very large share of the work of *advancing* Science, and is fully entitled to be periodically represented in the Presidency of the whole Association.

I trust also I shall prove to you that applications of Science and discoveries in pure Science act and re-act the one upon the other. I hope in this to carry the bulk of my audience with me, although there are some, I know, whose feelings, from a false notion of respect for Science, would probably find vent in the "toast" which one has heard in another place—this "toast" being attributed to the Pure Scientist—"Here's to the latest scientific discovery: may it never do any good to anybody!"

To give an early illustration of this action and re-action, which I contend occurs: take the well-worn story of Galileo, Torricelli, and the pump-maker. It is recorded that Galileo first and his pupil Torricelli afterwards were led to investigate the question of atmospheric pressure by observing the failure of a pump to raise water by "suction" above a certain level. Perhaps you will say the pump-maker was not applying science, but was working without science. I answer, he was unknowingly applying it, and it was from that which arose in this unconscious application that the mind of the Pure Scientist was led to investigate the subject, and thereupon to discover the primary fact, of the pressure of the atmosphere, and the subsidiary facts which attend thereon. It may appear to many of you that the question of the exercise of pressure by the atmosphere should have been so very obvious, but little merit ought to have accrued to the discoverer; and that the statement, once made, must have been accepted almost as a mere truism. This was, however, by no means the case. Sir Kenelm Digby in his "Treatise on the Nature of Bodies" printed in 1658, disputes the proposition altogether, and says, in effect, he is quite sure the failure of the pump to raise water was due to imperfect workmanship of some kind or description, and had nothing to do with the pressure of the air; and that there is no reason why a pump should not suck up water to any height. He cites the boy's sucker, which, when applied to a smooth stone, will lift it, and he says the reason why the stone follows the sucker is this. Each body must have some other body in contact with it. Now, the stone being in contact with the sucker, there is no reason why

that contact should be broken up for the mere purpose of substituting the contact of another body, such as the air. It seems pretty clear, therefore, that even to an acute and well-trained mind, such as that of Sir Kenelm Digby, it was by no means a truism, and to be forthwith accepted when once stated, that the rise of water on the "suction side" of a pump was due to atmospheric pressure. I hardly need point out that the pump-maker should have been a member of "G." Galileo and Torricelli, led to reflect by what they saw, should have been members of "A" of the then "Association for the Advancement of Science."

But, passing away from the question of the value of the application of Science of a date some two and a half centuries ago, let us come a little nearer to our own time.

Electricity—known in its simplest form to the Greeks by the results arising from the friction on amber, and named therefrom; afterwards produced from glass cylinder machines or from plate machines; and produced a century ago by the "Influence" machine—remained, as did the discoveries of Volta and Galvani, the pursuit of but a few, and even the brilliant experiments of Davy did not suffice to give very great impetus to this branch of physical science.

Ronalds in 1823 constructed an electric telegraph. In 1837 the first commercial use was made of the telegraph, and from that time electrical science received an impulse such as it had never before experienced. Further scientific facts were discovered; fresh applications were made of these discoveries. These fresh applications led to renewed vigour in research, and there was the action and reaction of which I have spoken. In the year 1871 the Society of Telegraph Engineers was established. In the year 1861 our own Association had appointed a Committee to settle the question of electrical standards of resistance, which Committee, with enlarged functions, continued its labours for twenty years, and of this Committee I had the honour of being a member. The results of the labours of that Committee endure (somewhat modified, it is true), and may be pointed to as one of the evidences of the value of the work done by the British Association. Since Ronalds's time, how vast are the advances which have been made in electrical communication of intelligence, by land lines, by submarine cables all over the world, and by the telephone! Few will be prepared to deny the statement that pure electrical science has received an enormous impulse, and has been advanced by the commercial application of electricity to the foregoing and to purposes of lighting. Since this latter application scores, I may say hundreds, of acute minds have been devoted to electrical science, stimulated thereto by the possibilities and probabilities of this application.

In this country, no doubt, still more would have been done if the lighting of districts from a central source of electricity had not been since 1882 practically forbidden by the Act passed in that year. This Act had in its title the facetious statement that it was "to facilitate Electrical Lighting"—although it is an Act which, even modified as it has been this year, is still a great discouragement of free enterprise and a bar to progress. The other day a member of the House of Commons was saying to me: "I think it is very much to our discredit in England that we should have allowed ourselves to be outrun in the distribution of electric lighting to houses by the inhabitants of the United States, and by those of other countries." Looking upon him as being one of the authors of the "facetious" Act I thought it pertinent to quote the case of the French parricide, who, being asked what he has to say in mitigation of punishment, pleads "Pity a poor orphan"—the parricide and the legislator being both of them authors of conditions of things which they affect to deplore. I will say no more on this subject, for I feel that it would not be right to take advantage of my position here to-night to urge Political Economy views, which should be reserved for Section F. I will merely, and as illustrative of my views of the value of the application of Science to Science itself, say there is no branch of physics pursued with more zeal and with more happy results than that of electricity with its allies, and there is no branch of Science towards which the public looks with greater hope of practical benefits; a hope that, I doubt not, will be strengthened after we have had the advantage of hearing one of the ablest followers of that science, Professor Ayrton, who, on Friday next, has been good enough to promise to discourse on "The Electrical Transmission of Power."

One of the subjects which, as much as (or probably more than) any other, occupies the attention of the engineer, and therefore of Section G, is that of (the so-called) Prime Movers, and I will say boldly that, since the introduction of printing by the use of movable type, nothing has done so much for civilisation as the development of these machines. Let us consider these prime movers—and, first, in the comparatively humble function of replacing that labour which might be performed by the muscular exertion of human beings, a function which at one time was looked upon by many kindly but short-sighted men as taking the bread out of the mouth of the labourer (as it was called), and as being therefore undesirable. I remember re-visiting my old schoolmaster, and his saying to me, shaking his head:—"So you have gone the way I always feared you would, and are making things of iron and brass to do the work of men's hands."

It must be agreed that all honest and useful labour is honourable, but when that labour can be carried out without the exercise of any intelligence, one cannot help feeling that the result is likely to be intellectually lowering. Thus, it is a sorry thing to see unintelligent labour, even although that labour be useful. It is but one remove from unintelligent labour which is not useful; that kind of labour generally appointed (by means of the tread-wheel or the crank) as a punishment for crime. Consider even the honourable labour (for it is useful, and it is honest) of the man who earns his livelihood by turning the handle of a crane, and compare this with the labour of a smith, who, while probably developing more energy by the use of his muscles than is developed by the man turning the crane-handle, exercises at the same time the powers of judgment, of eye, and of hand in a manner which I never see without my admiration being excited. I say that the introduction of prime movers as a mere substitute for unintelligent manual labour is in itself a great aid to civilisation and to the raising of humanity by rendering it very difficult, if not impossible, for a human being to obtain a livelihood by unintelligent work—the work of the horse in the mill, or of the turnspit.

But there are prime movers and prime movers—those of small dimensions, and employed for purposes where animal power or human power might be substituted, and those which attain ends that by no conceivable possibility could be attained at all by the exertion of muscular power.

Compare a galley, a vessel propelled with oars, with the modern Atlantic liner; and first let us assume that prime movers are non-existent, and that this vessel is to be propelled galley-fashion. Take her length as some 600 feet, and assume that place be found for as many as 400 oars on each side, each oar worked by three men, or 2400 men; and allow that six men under these conditions could develop work equal to one horse-power: we should have 400 horse-power. Double the number of men, and we should have 800 horse-power, with 4800 men at work, and at least the same number in reserve, if the journey is to be carried on continuously. Contrast the puny result thus obtained with the 19,500 horse-power given forth by a large prime mover of the present day, such a power requiring, on the above mode of calculation, 117,000 men at work and 117,000 in reserve; and these to be carried in a vessel less than 600 feet in length. Even if it were possible to carry this number of men in such a vessel, by no conceivable means could

their power be utilised so as to impart to it a speed of twenty knots an hour.

This illustrates how a prime mover may not only be a mere substitute for muscular work, but may afford the means of attaining an end, that could not by any possibility be attained by muscular exertion, no matter what money was expended or what galley-slave suffering was inflicted.

Take again the case of a railway locomotive. From 400 to 600 horse-power developed in an implement which, even including its tender, does not occupy an area of more than fifty square yards, and that draws us at sixty miles an hour. Here again, the prime mover succeeds in doing that which no expenditure of money or of life could enable us to obtain from muscular effort.

To what, and to whom, are these meritorious prime movers due? I answer: To the application of science, and to the labours of the civil engineer, using that term in its full and proper sense, as embracing all engineering other than military. I am, as you know, a Civil Engineer, and I desire to laud my profession and to magnify mine office; and I know of no better means of doing this than by quoting to you the definition of "civil engineering," given in the Charter of The Institution of Civil Engineers, namely, that it is "the art of directing the great sources of power in Nature for the use and convenience of man." These words are taken from a definition or description of engineering given by one of our earliest scientific writers on the subject, Thomas Tredgold, who commences that description by the words above quoted, and who, having given various illustrations of the civil engineer's pursuits, introduces this pregnant sentence:—

"This is, however, only a brief sketch of the objects of civil engineering, the real extent to which it may be applied is limited only by the progress of science; its scope and utility will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical art, since its bounds are unlimited, and equally so must be the researches of its professors."

"The art of directing the great sources of power in Nature for the use and convenience of man." Among all secular pursuits, can there be imagined one more vast in its scope, more beneficent, and therefore more honourable, than this? There are those, I know—hundreds, thousands—who say that such pursuits are not to be named as on a par with those of literature; that there is nothing ennobling in them; nothing elevating; that they are of the earth, earthy; are mechanical, and are unintellectual, and that even the mere bookworm, who, content with storing his own mind, neither distributes those stores to others nor himself originates, is more worthily occupied than is the civil engineer.

I deny this altogether, and, while acknowledging, with gratitude, that, in literature, the masterpieces of master minds have afforded, and will afford instruction, delight, and solace for all generations, so long as civilisation endures, I say that the pursuits of civil engineering are worthy of occupying the highest intelligence, and that they are elevating and ennobling in their character.

Remember the kindly words of Sir Thomas Browne, who said, when condemning the uncharitable conduct of the mere bookworm, "I make not, therefore, my head a grave, but a treasure of knowledge, and study not for mine own sake only, but for those who study not for themselves." The engineer of the present day finds that he must not make his "head a grave," but that, if he wishes to succeed, he must have, and must exercise, scientific knowledge; and he realises daily the truth that those who are to come after him must be trained in science, so that they may readily appreciate the full value of each scientific discovery as it is made. Thus, the application of science by the engineer not only stimulates those who pursue science, but adds him to their number.

Holding, as I have said I do, the view that he who displaces unintelligent labour is doing good to mankind, I claim for the unknown engineer who, in Pontus, established the first water-wheel of which we have a record, and for the equally unknown engineer who first made use of wind for a motor, the title of pioneers in the raising of the dignity of labour, by compelling the change from the non-intelligent to the intelligent.

With respect to these motors—wind and water—we have two proverbs which discredit them: "Fickle as the wind," "Unstable as water."

Something more trustworthy was needed—something that we were sure of having under our hands at all times. As a result, Science was applied, and the "fire" engine, as it was first called, the "steam" engine, as it was renamed, a form of "heat" engine, as we now know it to be, was invented.

Think of the early days of the steam engine—the pre-Watt days. The days of Papin, Savory, Newcomen, Smeaton! Great effects were produced, no doubt, as compared with no fire engine at all; effects so very marked as to extort from the French writer, Belidor, the tribute of admiration he paid to the "fire" engine erected at the Fresnes Colliery by English Engineers. A similar engine worked the pumps in York Place (now the Adelphi) for the supply of water to portions of London. We have in his work one of the very clearest accounts, illustrated by the best engravings (absolute working drawings) of the engine which had excited his admiration. These drawings show the open-topped cylinder, with condensation taking place below the piston, but with the valves worked automatically.

It need hardly be said that, noteworthy as such a machine was, as compared with animal power, or with wind or water motors, it was of necessity a most wasteful instrument as regards fuel. It is difficult to conceive in these days how, for years, it could have been endured that, at each stroke of the engine, the chamber that was to receive the steam at the next stroke was carefully cooled down beforehand by a water injection.

Watt, as we know, was the first to perceive, or, at all events, to cure, this fundamental error, which existed prior to his time in the "fire" engine. To him we owe condensation in a separate vessel, the doing away with the open-topped cylinder, and the making the engine double-acting; the parallel motion; the governor; and the engine indicator, by which we have depicted for us the way in which the work is being performed within the cylinder. To Watt, also, we owe that great source of economic working—the knowledge of the expansive force of steam; and to his prescience we owe the steam jacket, without which expansion, beyond certain limits, is practically worthless. I have said "prescience"—fore-knowledge—but I feel inclined to say that, in this case, prescience may be rendered "pre-Science" for I think that Watt *felt* the utility of the steam jacket, without being able to say on what ground that utility was based.

I have already spoken in laudatory terms of Tredgold, as being one of the earliest of our scientific engineering writers, but, as regards the question of steam jacketing, Watt's prescience was better than Tredgold's science, for the latter condemns the steam jacket, as being a means whereby the cooling surfaces are enlarged, and whereby, therefore, the condensation is increased.

I think it is not too much to say that engineers who, since Watt's days, have produced machines of such marvellous power—and, compared with the engines of Watt's days, of so great economy—have, so far as principles are concerned, gone upon those laid down by Watt. Details of the most necessary character—necessary to enable those principles to be carried out—have, indeed, been devised since the days of Watt. Although it is still a very sad confession to have to make, that the very best of our steam engines only utilises about one-sixth of the work which resides (if the term may be used) in the fuel that is consumed, it is, nevertheless, a satisfaction to know that great economical progress has been made, and that the 6 or 7 lbs. of fuel per horse-power per hour consumed by the very best engines of Watt's days, when working with the aid of condensation, is now brought down to about

one-fourth of this consumption; and this in portable engines, for agricultural purposes, working without condensation—engines of small size, developing only 20 horse-power; in such engines the consumption has been reduced to as little as 1·85 lbs. per brake horse-power per hour, equal to 1·65 lbs. per indicated horse-power per hour, as was shown by the trials at the Royal Agricultural Society's meeting at Newcastle last year—trials in which I had the pleasure of participating.

In these trials Mr. William Anderson, one of the Vice-Presidents of Section G, and I were associated, and, in making our report of the results, we adopted the balance-sheet system, which I suggested and used so long ago as 1873 (see vol. lii., pp. 154 and 155, of the *Minutes and Proceedings of the Institution of Civil Engineers*), and to which I alluded in my address as President of G at Montreal.

I have told you that the engineer of the present day appreciates the value of the "next-to-nothings." There is an old housekeeping proverb that, if you take care of the farthings and the pence, the shillings and the pounds will take care of themselves. Without the balance-sheet one knows that for the combustion of 1 lb. of coal, the turning into steam of a given quantity of water at a given pressure is obtained. It is seen, at once, that the result is much below that which should be had, but to account for the deficiency is the difficulty. The balance-sheet, dealing with the most minute sources of loss,—the farthings and the pence of economic working,—brings you face to face with these, and you find that improvement must be sought in paying attention to the "next-to-nothings."

Just one illustration. The balance-sheet will enable you at a glance to answer this among many important questions. Has the fuel been properly burnt?—with neither too much air nor too little.

At the Newcastle trials our knowledge as to whether we had the right amount of air for perfect combustion was got by an analysis of the waste gases, taken continuously throughout the whole number of hours' run of each engine, affording, therefore, a fair average: the analysis of any required portion of gases thus obtained was made in a quarter of an hour's time by the aid of the admirable apparatus invented by Mr. Stead, and, on the occasion to which I refer, manipulated by him. In one instance an excess of air had been supplied, causing a percentage of loss of 6·34. In the instance of another engine there was a deficiency of air, resulting in the production of carbonic oxide, involving a loss of 4 per cent. The various percentages of loss, of which each one seems somewhat unimportant, in the aggregate amounted to 28 per cent, and this with one of the best boilers. This is an admirable instance of the need of attention to apparently small things.

I have already said that we now know the steam engine is really a heat engine. At the York Meeting of our Association I ventured to predict that, unless some substantive improvement were made in the steam engine (of which improvement, as yet, we have no notion), I believed its days, for small powers, were numbered, and that those who attended the centenary of the British Association in 1931 would see the present steam engines in museums, treated as things to be respected, and of antiquarian interest to the engineers of those days, such as are the open-topped steam cylinders of Newcomen and of Smeaton to ourselves. I must say I see no reason, after the seven years which have elapsed since the York Meeting, to regret having made that prophecy, or to desire to withdraw it.

The working of heat engines, without the intervention of the vapour of water, by the combustion of the gases arising from coal, or from coal and from water, is now not merely an established fact, but a recognised and undoubted, commercially economical, means of obtaining motive power. Such engines, developing from 1 to 40 horse-power, and worked by the ordinary gas supplied by the gas mains, are in most extensive use in printing works, hotels, clubs, theatres, and even in large private houses, for the working of dynamos to supply electric light. Such engines are also in use in factories, being sometimes driven by the gas obtained from "culm" and steam, and are giving forth a horse-power for, it is stated, as small a consumption as one pound of fuel per hour.

It is hardly necessary to remind you—but let me do it—that, although the saving of half a pound of fuel per horse-power appears to be insignificant when stated in that bald way, one realises that it is of the highest importance when that half-pound turns out to be 33 per cent of the whole previous consumption of one of those economical engines to which I have referred.

The gas engine is no new thing. As long ago as 1807 a M. de Rivaz proposed its use for driving a carriage on ordinary roads. For anything I know he may not have been the first proposer. It need hardly be said that in those days he had not illuminating gas to resort to, and he proposed to employ hydrogen. A few years later a writer in *Nicholson's Journal*, in an article on "flying machines," having given the correct statement that all that is needed to make a successful machine of this description is to find a sufficiently light motor, suggests that the direction in which this may be sought is the employment of illuminating gas, to operate by its explosion on the piston of an engine. The idea of the gas engine was revived, and formed the subject of a patent by Barnett in the year 1838. It is true this gentleman did not know very much about the subject, and that he suggested many things which, if carried out, would have resulted in the production of an engine which could not have worked; but he had an alternative proposition which would have worked.

Again, in the year 1861, the matter was revived by Lenoir, and in the year 1865 by Hugon, both French inventors. Their engines obtained some considerable amount of success and notoriety, and many of them were made and used; but in the majority of cases they were discarded as wasteful and uncertain. The Institution of Civil Engineers, for example, erected a Lenoir in the year 1868, to work the ventilating fan, but after a short time they were compelled to abandon it and to substitute an hydraulic engine.

At the present time, as I have said, gas engines are a great commercial success, and they have become so by the attention given to small things, in popular estimation—to important things, in fact, with which, however, I must not trouble you. Messrs. Crossley Brothers, who have done so much to make the gas engine the commercial success that it is, inform me that they are prosecuting improvements in the direction of attention to detail, from which they are obtaining greatly improved results.

But, looking at the wonderful petroleum industry, and at the multifarious products which are obtained from the crude material, is it too much to say that there is a future for motor engines worked by the vapour of some of the more highly volatile of these products,—true vapour,—not a gas, but a condensable body, capable of being worked over and over again? Numbers of such engines, some of as much as 4 horse-power, made by Mr. Yarrow, are now running, and are apparently giving good results,—certainly excellent results as regards the compactness and lightness of the machinery; for boat purposes they possess the great advantage of being rapidly under way. I have seen one go to work within two minutes of the striking of the match to light the burner.

Again, as we know, the vapour of this material has been used as a gas in gas engines, the motive power having been obtained by direct combustion.

Having regard to these considerations, was I wrong in predicting that the heat engine of the future will probably be one independent of the vapour of water? And, further, in these days of electrical advancement, is it too much to hope for the direct production of electricity from the combustion of fuel?

As the world has become familiar with prime movers, the desire for their employment has increased. Many a householder could find useful occupation for a prime mover of ¼ or ½ horse-power, working one or two hours a day; but the economical establishment of a steam engine is not possible until houses of very large dimensions are reached, where space exists for the engine, and where, having regard to the amount of work to be done, the incidental expenses can be borne. Where this cannot be, either the prime mover, with the advantages of its use, must be given up as a thing to be wished for, but not to be procured, or recourse must be had to some other contrivance,—say to the laying on of power, in some form or another, from a central source.

I have already incidentally touched upon one mode of doing this, namely, the employment of illuminating gas as the working agent in the gas engine; but there are various other modes, possessing their respective merits and demerits,—all ingenious, all involving science in their application, and all more or less in practical use,—such as the laying-on of special high-pressure water, as is now being extensively practised in London, in Hull, and elsewhere. Water at 700 lbs. pressure per inch is a most convenient mode of laying on a large amount of power through comparatively small pipes. Like electricity, where, when a high electromotive force is used, a large amount of energy may be sent through a small conductor, so with water, under high pressure, the mains may be kept of reasonable diameters without rendering them too small to transmit the power required through them.

Power is also transmitted by means of compressed air, an agent which, on the score of its ability to ventilate, and of its cleanliness, has much to recommend it. On the other hand, it is an agent which, having regard to the probability of the deposition of moisture in the form of "snow," requires to be worked with judgment.

Again, there is an alternative mode for the conveyance of power by the exhaustion of air,—a mode which has been in practical use for over sixty years.

We have also the curious system pursued at Schaffhausen, where quick-running ropes are driven by turbines, these being worked by the current of the River Rhine; and at New York, and in other cities of the United States, steam is laid on under the streets, so as to enable domestic steam engines to be worked, without the necessity of a boiler, a stoker, or a chimney, the steam affording also means of heating the house when needed.

Lastly, there is the system of transmitting power by electricity, to which I have already adverted. I was glad to learn, only the other day, that there was every hope of this power being applied to the working of an important subterranean tramway.

These distributions from central sources need, as a rule, statutory powers to enable the pipes or wires to be placed under the roads; and, following the deplorable example of the Electrical Facilities Act, it is now the habit of the enlightened corporation and the enterprising town clerk of most boroughs to say to capitalists who are willing to embark their capital in the plant for the distribution of power from a central source—for their own profit, no doubt, but also, no doubt, for the good of the community —"We will oppose you in Parliament, unless you will consent that, at the end of twenty-one years, we may acquire compulsorily your property, and may do so, if it turns out to be remunerative, without other payment than that for the mere buildings and plant at that time existing." This is the way English enterprise is met, and then English engineers are taunted, by Englishmen—often by the very men who have had a share in making this "boa-constrictor" of a "Facilities Act"—that their energy is not to be compared with that which is to be found in the United States and other countries. Again, however, I must remember that I am not addressing Section F.

There is one application of science, by engineers, which is of extreme beauty and interest, and that cannot be regarded with indifference by the agriculturists of this country. I allude to the Heat-withdrawing Engines (I should like to say "Cold-Producers," but I presume, if I did, I should be criticised) which are now so very extensively used for the importation of fresh meat, and for its storage when received here. It need hardly be said that that which will keep cool and sweet the carcases of sheep will equally well preserve milk, and many other perishable articles of food. We have in these machines daily instances that, if you wish to make a ship's hold cold, you can do it by burning a certain quantity of coals—a paradox, if ever there was one.

In this climate of ours, where the summer has been said to consist of "three hot days and a thunderstorm," there is hardly need to make a provision for cooling our houses, although there is an undoubted need for making a provision to heat them. Nevertheless, those of us who have hot-water heating arrangements for use in the winter would be very glad indeed if, without much trouble or expense, they could turn these about, so as to utilise them for cooling their houses in summer. Mr. Loftus Perkins, so well known for his labours in the use of very high-pressure steam (600 to 1000 lbs. on the inch), and also so well known for those most useful high pressure warming arrangements which, without disfiguring our houses by the passage of large pipes, keep them in a state of warmth and comfort throughout the winter, has lately taken up the mode of, I will say it, producing "cold" by the evaporation of ammonia, and, by improvements in detail, has succeeded in making an apparatus which, without engine or pumps, produces "cold" for some hours in succession, and requires, to put it in action, the preliminary combustion of only a few pounds of coke or a few feet of gas.

As I have said, our climate gives us but little need to provide or employ apparatus to cool our houses, but one can well imagine that the Anglo-Indian will be glad to give up his punkah for some more certain and less draughty mode of cooling.

I now desire to point out how, as the work of the engineer grows, his needs increase. New material, or better material of the old kind, has to be found to enable him to carry out these works of greater magnitude. At the beginning of this century, stone, brick, and timber were practically the only materials employed for that which I may call standing engineering work,—*i.e.*, buildings, bridges, aqueducts, and so on,—while timber, cast iron, and wrought iron were for many years the only available materials for the framing and principal parts of moving machines and engines, with the occasional use of lead for the pipes and of copper for pipes and for boilers.

As regards the cast iron, little was known of the science involved (or that ought to be involved) in its manufacture. It was judged of by results. It was judged of largely by the eye. It was "white," it was "mottled," it was "grey." It was known to be "fit for refining," fit for "strong castings," or fit for castings in which great fluidity in the molten metal was judged to be of more importance than strength in the finished casting. With respect to wrought iron, it was judged of by its results also. It was judged of by the place of its manufacture; but when the works of the district were unknown, the iron, on being tested, was classed as "good fibrous," although some of the very best was "steel-like," or "bad," "hot-short," or "cold-short." A particular district would produce one kind of iron, another district another kind of iron. The ore, the flux, and the fuel were all known to have influence, but to what extent was but little realised; and if there came in a new ore, or a new flux, it might well be that for months the turn-out of the works into which these novelties had been introduced would be prejudiced. Steel again—that luxury of the days of my youth—was judged by the eye. The wrought bars, made into "blister" steel by "cementation," were broken, examined, and grouped accordingly. Steel was known, no doubt, to be a compound of iron and carbon, but the im-

portance of exactness in the percentage was but little understood, nor was it at all understood how the presence of comparatively small quantities of foreign matter might necessitate the variation of the proportions of carbon. The consequence was that anomalous results every now and then arose to confound the person who had used the steel, and, falsifying the proverb "true as steel," steel became an object of distrust. Is it too much to say that Bessemer's great invention of steel made by the "converter," and that Siemens's invention of the open-hearth process, reacted on pure science, and set scientific men to investigate the laws which regulate the union of metals and of metalloids? and that the labours of these scientific men have improved the manufacture, so that steel is now thoroughly and entirely trusted? By its aid engineering works are accomplished which, without that aid, would have been simply impossible. The Forth Bridge, the big gun, the compound armour of the ironclad with its steel face, the projectile to pierce that steel face—all equally depend upon the "truth" of steel as much as does the barely visible hairspring of the chronometer, which enables the longitude of the ship in which it is carried to be ascertained. Now, what makes the difference between trustworthy and untrustworthy steel for each particular purpose? Something which, until our better sense comes to our aid, we are inclined to look upon as ridiculously insignificant—a "next-to-nothing." Setting extraneous ingredients aside, and considering only the union of iron and carbon, the question whether there shall be added or deducted one-tenth of 1 per cent (pardon my clumsy way of using the decimal system) of carbon is a matter of great importance in the resulting quality of the steel. This is a striking practical instance of how apparently insignificant things may be of the highest importance. The variation of this fraction of a percentage may render your boiler steel untrustworthy, may make the difference between safety in a gun and danger in a gun, and may render your armour-piercing projectile unable to pierce even the thinnest wrought-iron armour.

While thus brought incidentally to the subject of guns, let me derive from it another instance of the value of small things. I have in my hand a piece of steel ribbon. It is probable that only those who are near to me can see it. Its dimensions are one-fourth by one-sixteenth of an English inch, equal to an area of one sixty-fourth of a square inch. This mode of stating the dimensions I use for the information of the ladies. To make it intelligible to my scientific friends, I must tell them that it is approximately 0·00637 of a metre, by approximately 0·00159 of a metre, and that its sectional area is 0·0000101283 (also approximately) of a square metre. This insignificant (and speaking in reference to the greater number of my audience) practically invisible piece of material—that I can bend with my hand, and even tie into knots—is, nevertheless, not to be despised. By it one reinforces the massive and important-looking A-tube of a 9·2 inch gun, so that from that tube can be projected with safety a projectile weighing 380 pounds at a velocity, when leaving the muzzle, of between one-third and one-half of a mile in a second, and competent to traverse nearly 12½ miles before it touches the ground. It may be said, "What is the use of being able to fire a projectile to a distance which commonly is invisible (from some obstacle or another) to the person directing the gun?" I will suggest to you a use. Imagine a gun of this kind placed by some enemy who, unfortunately, had invaded us, and had reached Richmond. He has the range table for his gun; he, of course, is provided with our Ordnance maps, and he lays and elevates the gun at Richmond, with the object of striking, say, the Royal Exchange. Suppose he does not succed in his exact aim. The projectile goes 100 yards to one side or to the other; or it falls 250 yards short, or passes 250 yards over; and it would be "bad shooting" indeed, in these days, if nearly every projectile which was fired did not fall somewhere within an area such as this. In this suggested parallelogram of 100,000 square yards, or some 20 acres, there is some rather valuable property; and the transactions which are carried on are not unimportant. It seems to me that business would not be conducted with that calmness and coolness which are necessary for success if, say every five minutes, a 380-pound shell fell within this area, vomiting fire, and scattering its walls in hundreds of pieces, with terrific violence, in all directions. Do not suppose I am saying that similar effects cannot be obtained from a gun where wire is not employed. They can be. But my point is, that they can also be obtained by the aid of the insignificant thing which I am holding up at this moment—this piece of steel ribbon, which looks more suitable for the framework of an umbrella.

I have already spoken to you, when considering steel as a mere alloy of iron and carbon, as to the value of even a fraction of one per cent of the latter; but we know that in actual practice steel almost always contains other ingredients. One of the most prominent of these is manganese. It had for years been used, in quantities varying from a fraction of 1 per cent up to 2·5 per cent, with advantage as regards ductility, and as regards its ability to withstand forging. A further increase was found not to augment the advantage: a still further increase was found to diminish it; and here the manufacturer stopped, and, so far as I know, the pure scientist stopped, on the very reasonable ground that the point of increased benefit appeared to have been well ascertained, and that there could be no advantage in pursuing an investigation which appeared only to result in decadence. But this is another instance of how the application of science reacts in the interests of pure science itself. One of our steel manufacturers, Mr. Hadfield, determined to pursue this apparently barren subject, and in doing so discovered this fact—that, while with the addition of manganese in excess of the limit before stated, and up to as much as 7 per cent, deterioration continued, after this latter percentage was passed improvement again set in.

Again, the effects of the addition of even the very smallest percentages of aluminium upon the steel with which it may be alloyed are very striking and very peculiar, giving to the steel alloy thus produced a very much greater hardness, and enabling it to take a much brighter and more silver-like polish. Further, the one-twentieth part of 1 per cent of aluminium, when added to molten wrought iron, will reduce the fusing-point of the whole mass some 500 degrees, and will render it extremely fluid, and thus enable wrought-iron (or what are commercially known as "Mitis"—castings of the most intricate character) to be produced.

No one has worked more assiduously at the question of the effect of the presence of minute quantities, even traces, of alloys with metals than Professor Roberts-Austen, and he appears, by his experiments, to be discovering a general law, governing the effect produced by the mixture of particular metals, so that, in future, it is to be hoped, when an alloy is, for the first time, to be attempted, it will be possible to predict with reasonable certainty what the result will be, instead of that result remaining to be discovered by experiment.

I have just, incidentally, mentioned aluminium. May I say that we engineers look forward, with much interest, to all processes tending to bring this metal, or its alloys, within possible commercial use?

One more instance of the effect of impurities in metals. The engineer engaged in electrical matters is compelled, in the course of his daily work, frequently to realise the importance of the "next-to-nothing." One striking instance of this is afforded by the influence which an extremely minute percentage of impurity has on the electrical conductivity of copper wire: this conductivity being in some cases reduced by as much as 50 per cent, in consequence of the admixture of that which, under other circumstances, would be looked upon as insignificant.

Reverting to the question of big guns. According to

the present mode of manufacture, after we have rough-bored and turned the "A" tube (and perhaps I ought to have mentioned that by the "A" tube is meant the main piece of the gun, the innermost layer, if I may so call it, that portion which is the full length of the gun, and upon which the remainder of the gun is built up)—after, as I have said, we have rough-bored and turned this "A" tube, we heat it to a temperature lying between certain specified limits, but actually determined by the behaviour of samples previously taken, and then suddenly immerse it perpendicularly into a well some 60 feet deep, full of oil, the oil in this well being kept in a state of change by the running into it, at the bottom, of cold oil conveyed by a pipe proceeding from an elevated oil tank. In this way the steel is oil-hardened, with the result of increasing its ultimate tensile strength, and also with the result of raising its so-called elastic limit. In performing this operation it is almost certain that injurious internal strains will be set up: strains tending to produce self-rupture of the material. Experiments have been carried out in England by Captain Andrew Noble, and by General Maitland, of the Royal Gun Factory, by General Kalakoutsky, in Russia, and also in the United States, to gauge what is the value, as represented by dimensions, of these strains, and we find that they have to be recorded in the most minute fractions of an inch, and yet, if the steel be of too "high" a quality (as it is technically called), or if there has been any want of uniformity in the oil-hardening process, these strains, unless got rid of or ameliorated by annealing, may, as I have said, result in the self-rupture of the steel.

I have spoken of the getting rid of these strains by annealing, a process requiring to be conducted with great care, so as not to prejudice the effects of the oil-hardening. But take the case of a hardened steel projectile, hardened so that it will penetrate the steel face of compound armour. In that case annealing cannot be resorted to, for the extreme hardness of the projectile must not be in the least impaired. The internal strains in these projectiles are so very grave that for months after they are made there is no security that they will not spontaneously fracture. I have here the point of an 8-inch projectile, which projectile weighs 210 lbs.; this, with others, was received from the makers as long ago as March of this year, and remained an apparently perfect and sound projectile until about the middle of August—some five months after delivery—and, of course, a somewhat longer time since manufacture—and between August 6th and 8th this piece which I hold in my hand, measuring 3¾ inches by 3½ inches, spontaneously flew off from the rest of the projectile, and has done so upon a surface of separation which, whether having regard to its beautiful regularity, or to the conclusions to be drawn from it as to the nature of the strains existing, is of the very highest scientific interest. Many other cases of self-rupture of similar projectiles have been recorded.

Another instance of the effect of the "next-to-nothing" in the hardening and tempering or annealing of steel. As we know, the iron and the carbon (leaving other matters out of consideration) are there. The carbon is (even in tool-steel) a very small proportion of the whole. The steel may be bent, and will retain the form given to it. You heat it and plunge it in cold water; you attempt to bend it and it breaks; but if, after the plunging in cold water, you temper it by carefully re-heating it, you may bring it to the condition fit either for the cutting-tool for metal, or for the cutting-tool for wood, or for the watch-spring; and these important variations of condition which are thus obtained depend upon the "next-to-nothing" in the temperature to which it is re-heated, and therefore in the nature of the resulting combination of the ingredients of which the steel is composed.

Some admirable experiments were carried out on this subject by the Institution of Mechanical Engineers, with the assistance of one of our Vice-Presidents, Sir Frederick Abel, and the subject has also been dealt with by an eminent Russian writer.

There is, to my mind, another and very striking popular instance (if I may use the phrase) of the importance of attention to detail—that is, to the "next-to-nothing.', Consider the bicycles and tricycles of the present day—machines which afford the means of healthful exercise to thousands, and which will, probably within a very short time, prove of the very greatest possible use for military purposes. The perfection to which these machines have been brought is almost entirely due to strict attention to detail; in the selection of the material of which the machines are made; in the application of pure science (in its strictest sense) to the form and to the proportioning of the parts, and also in the arrangement of these various parts in relation the one to the other. The result is that the greatest possible strength is afforded with only the least possible weight, and that friction in working has been reduced to a minimum. All of us who remember the hobby-horse of former years, and who contrast that machine with the bicycle or tricycle of the present day, realise how thoroughly satisfactory is the result of this attention to detail—this appreciation of the "next-to-nothing."

Let me give you another illustration of the importance of small things, drawn from gunnery practice.

At first sight one would be tempted to say that the density of the air on the underside of a shot must, notwithstanding its motion of descent, be so nearly the same as that of the air upon the upper side as to cause the difference to be unworthy of consideration, but we know that the projectiles from rifled guns tend to travel sideways as they pass through the air, and that the direction of their motion, whether to the right or to the left, depends on the "hand" of the rifling. We know also, that the friction against liquid or against gaseous bodies varies with the densities of these bodies, and it is believed that, minute as is the difference in density to which I have referred, it is sufficient to determine the lateral movement of the projectile. This lateral tendency must be allowed for, in these days of long ranges, in the sighting and laying of guns, if we desire accuracy of aim, at those distances at which it is expected our naval engagements will have to be commenced, and perhaps concluded. We can no longer afford to treat the subject as Nelson is said to have treated it in one of his letters to the Secretary of the Admiralty, who had requested that an invention for laying guns more accurately should be tried. Nelson said he would be glad to try the invention, but that, as his mode of fighting consisted in placing his ship close alongside that of the enemy, he did not think the invention, even if it were successful, would be of much use to him.

While upon the question of guns, I am tempted to remark upon that which is by no means a small thing (for it is no less than the rotation of the earth), which in long-distance firing may demand attention, and that to an extent little suspected by the civilian.

Place the gun north and south, say in the latitude of London, and fire a 12-mile round such as I have mentioned, and it will be found that, assuming the shot were passing through a vacuum, a lateral allowance of more than 200 feet must be made to compensate for the different velocity of the circumference of the earth at 12 miles north or south of the place where the gun was fired, as compared with the velocity of the circumference of the earth at that place itself—the time of flight being in round numbers one minute.

At the risk of exciting a smile, I am about to assert that engineering has even its poetical side. I will ask you to consider with me whether there may not be true poetry in the feelings of the engineer who solves a problem such as this: Consider this rock, never visible above the surface of the tide, but making its presence known by the waves which rise around it: it has been the cause of destruction to many a noble vessel which had completed, in safety, its thousands of leagues of journey, and was within a few score miles of port; then dashed to pieces upon it? Here is this rock. On it build a lighthouse. Lay your foundations through the water, in the midst of

the turmoil of the sea; make your preparations; appear to be attaining success, and find the elements are against you and that the whole of your preliminary works are ruined or destroyed in one night; but again commence, and then go on and go on until at last you conquer; your works rise above ordinary tide-level; then upon these sure foundations, obtained it may be after years of toil, erect a fair shaft, graceful as a palm and sturdy as an oak; surmount it with a light, itself the produce of the highest application of science; direct that light by the built-up lens, again involving the highest application of science; apply mechanism, so arranged that the lighthouse shall from minute to minute reveal to the anxious mariner its exact name and its position on the coast. When you have done all this, will you not be entitled to say to yourself, "It is I who have for ever rendered innocuous this rock, which has been hitherto a dread source of peril"? Is there no feeling, do you think, of a poetical nature excited in the breast of the engineer who has successfully grappled with a problem such as this?

Another instance: the mouth of a broad river or, more properly speaking, the inlet of the sea has to be crossed at such a level as not to impede the passage of the largest ships. Except in one or two places the depth is profound, so that multiple foundations for supporting a bridge become commercially impossible, and the solution of the problem must be found by making high in the air a flight of span previously deemed unattainable. Is there no poetry here? Again, although the results do not strike the eye in the same manner, is there nothing of poetry in the work that has to be thought out and achieved, when a wide river or an ocean channel has to be crossed by a subterranean passage? Works of great magnitude of this character have been performed with success, and to the benefit of those for whose use they were intended. One of the greatest and most noble of such works, encouraged, in years gone by, by the Governments of our own country and of France, has lately fallen into disfavour with an unreasoning public, who have not taken the pains to ascertain the true state of the case.

Surely it will be agreed that the promotion of ready intercourse and communication between nations constitute the very best, and most satisfactory guarantees for the preservation of peace; when the peoples of two countries come to know each other intimately, and when they, therefore, enter into closer business relations, they are less liable to be led away by panic or by anger, and they hesitate to go to war the one with the other. It is in the interests of both that questions of difference which may arise between them should be amicably settled, and having an intimate knowledge of each other, they are less liable to misunderstand, and the mode of determination of their differences is more readily arranged. Remember, the means of ready intercourse and of communication, and the means of easy travel are all due to the application of science by the engineer. Is not therefore his profession a beneficent one?

Further, do you not think poetical feeling will be excited in the breast of that engineer who will in the near future solve the problem (and it certainly will be solved when a sufficiently light motor is obtained) of travelling in the air—whether this solution be effected by enabling the self-suspended balloon to be propelled and directed, or, perhaps better still, by enabling not only the propulsion to be effected and the direction to be controlled, but by enabling the suspension in the air itself to be attained by mechanical means?

Take other functions of the Civil Engineer—functions which, after all, are of the most important character, for they contribute directly to the prevention of disease, and thereby not only prolong life, but do that which is probably more important—afford to the population a healthier life while lived.

In one town, about which I have full means of knowing, the report has just been made that in the year following the completion of a comprehensive system of sewerage, the deaths from zymotic diseases had fallen from a total of 740 per annum to a total of 372—practically one-half. Has the engineer no inward satisfaction who knows such results as these have accrued from his work?

Again consider the magnitude and completeness of the water supply of a large town, especially a town that has to depend upon the storing-up of rain water: the prevision which takes into account, not merely the variation of the different seasons of the year, but the variation of one year from another; that, having collated all the stored-up information, determines what must be the magnitude of the reservoirs to allow for at least three consecutive dry years, such as may happen; and that finds the sites where these huge reservoirs may be safely built.

All these—and many other illustrations which I could put before you if time allowed—appear to me to afford conclusive evidence that whether it be in the erection of the lighthouse on the lonely rock at sea; whether it be in the crossing of rivers, or seas, or arms of seas by bridges or by tunnels; whether it be the cleansing of our towns from that which is foul; whether it be the supply of pure water to every dwelling, or the distribution of light, or of motive power; or whether it be in the production of the mighty ocean steamer, or in the spanning of valleys, the piercing of mountains, and affording the firm secure road for the express train; or whether it be the encircling of the world with telegraphs, the work of the Civil Engineer is not of the earth earthy, is not mechanical to the exclusion of science, is not unintellectual; but is of a most beneficent nature, is consistent with true poetical feeling, and is worthy of the highest order of intellect.

THE AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The formation of this Association, which already gives promise of being a great success, was first suggested by Professor Liversidge, of the Sydney University, during the Exhibition in Sydney, in 1879, but matters at that time not being considered quite ripe for it, the formation of the Association was again brought forward through the press in the year 1884. It was then suggested that, as it did not seem likely that the British Association would see their way to visit Australia during the Centennial year, an Australasian Association should be formed, on the same lines as the British Association, in order to bring about a federation or union of the members of the various scientific societies throughout Australasia.

It was also suggested that the first general meeting should be held in Sydney on the one-hundredth anniversary of the foundation of the Colony, as it was at that time thought there would be an International Exhibition in Sydney to celebrate that event. In furtherance of this object a preliminary meeting of delegates was held in Sydney in November, 1886, the project having met with the approbation and support of almost all the learned and scientific societies of Australasia.

At this meeting the formation of the Australasian Association for the Advancement of Science was agreed to unanimously, the rules of the British Association being adopted until the first general meeting, which it was decided should be held in Sydney during the year 1888.

In accordance with another resolution passed at the meeting of delegates the election of officers for the year took place in March of the present year, Mr. H. C. Russell, B.A., F.R.S, Government Astronomer, being elected President, Sir Edward Strickland, K.C.B., F.R.G.S., Hon. Treasurer, and Professor Liversidge, M.A., F.R.S., and Dr. George Bennett, F.L.S., Hon. Secs.

The formation of the Council was afterwards proceeded with, each learned or scientific society electing one representative for every hundred of its members; and the Chief

Justice, Minister for Public Instruction, the Chancellor and Vice-Chancellor of the Sydney University, the Mayor of Sydney, and the Presidents of the Royal Societies in other Colonies were elected Vice-Presidents for the year.

The Presidents of Sections were then elected, the gentlemen chosen being all resident in other Colonies than New South Wales, whilst the Secretaries of Sections, as a matter of necessity, were elected from amongst residents in Sydney.

The Association is hence thoroughly Australasian in its character, and the succeeding general meetings are to take place in turn in the capitals of the other Colonies, the executive officers being elected year by year by the Colony in which the meeting is held.

The first general meeting was to be held at the Sydney University, the opening ceremony, at which His Excellency the Governor will be present, taking place on Tuesday evening, August 28th, when the Presidential Address was delivered.

On the following day the Sectional meetings for the reading and discussion of papers commenced, and it is thought that the principal portion of the business will close with the end of the week.

Up to the present time the titles of about ninety papers have been sent in by gentlemen of distinction in Science, Literature, and Art in the different Colonies, and it seems probable that this number will be considerably increased before the meeting.

It may therefore be anticipated that the nature of the work done by the Association during the first year of its existence will be of a highly important and useful character.

The more solid work of the meeting is to be lightened by excursions to various places of interest to geologists, botanists, and others; and efforts are being made to provide for the entertainment and comfort of visiting members as far as possible, so that they may spend their time to the best advantage.

The various steamship companies have arranged to carry members proceeding to Sydney to attend the meeting at a reduction of 20 per cent on the ordinary rates, and it is anticipated that liberal concessions will also be granted in the railway fares.

The rules, as already mentioned, are practically the same as those of the British Association, and all who join the Association before the first general meeting in August become original members, without entrance fee, the subscription of £1 entitling members to receive the publications of the Association gratis.

The number of members at the end of July exceeded 400.

ON A METEORIC IRON FOUND IN 1884 IN THE SUB-DISTRICT OF YOUNDEGIN, WESTERN AUSTRALIA, AND CONTAINING CLIFTONITE, A CUBIC FORM OF GRAPHITIC CARBON.

By L. FLETCHER, M.A., F.C.S.,
President of the Mineralogical Society.

(Concluded from p. 107).

In the way detailed the composition of the iron was found to be as follows:—

Iron	92·67
Nickel	6·46
Cobalt	0·55
Copper	trace
Magnesium	0·42
Phosphorus	0·24
Sulphur	none
Insoluble cubes	0·04
Total	100·38

If the phosphorus be assumed to be wholly present in combination with iron and nickel, as Schreibersite, with the formula Fe_2NiP, and percentage composition—Iron 55·53, nickel 29·09, phosphorus 15·38, the above will correspond to—

Nickel-iron	98·82
Schreibersite	1·56
	100·38

As no opaque greyish-black mineral with a metallic lustre, and insoluble in aqua regia, is recognised as occuring in cubic crystals, the satisfactory determination of the nature of the insoluble residue of 3·1 milligrms. was expected to be a matter of some difficulty; further, two fragments of the iron, weighing 7 grms. and 2 grms. respectively, had not yielded a single crystal, and there was thus a possibility of the crystals being so localised as to render impracticable an increase of the quantity of material available for experiment.

The crystals were about a hundred in number, the average thickness of the larger ones being one-fourth of a millimetre (one-hundredth of an inch).

On all the crystals the faces of the cube are predominant; many are sharply defined simple cubes; some have their edges truncated by faces of the dodecahedron, as was proved by measurement on the goniometer; in others the edges are replaced by rounded faces of a tetrakis-hexahedron; or again, one or more of the cube-faces is replaced by a very obtuse, almost flat, square pyramid. One of the cubes shows re-entrant edges suggesting a lamellar growth. A little group of three parallel crystals was observed.

One of the crystals having been dropped on to a thin layer of red sealing-wax melted on a glass plate, was held sufficiently firm by the cooled wax to allow of its hardness and streak being determined. The hardness is greater than that of rock-salt, and less than that of calcite; it may be expressed as 2·5. The streak on white unglazed porcelain is black and shining.

The crystals are not affected by a magnet.

Of four crystals, two sank to the bottom, and two floated near the surface of a solution of sp. gr. 2·12.

The crystals remain unaltered when heated in a glass tube, closed at one end.

They are unattacked by nitro-hydrochloric, sulphuric, or hydrofluoric acids.

They float unaltered in beads of borax, microcosmic salt, or sodium carbonate, held in a blowpipe flame.

On dissolving in water a bead of sodium carbonate and potassium nitrate, in which three of the crystals had been heated, only one crystal was seen, and this was much reduced in size; the solution of the bead gave no evidence of the presence of chromium.

Similar beads, in each of which a crystal had been dissolved, were tested for phosphoric and silicic acids with negative results; nor did the solution of a bead in hydrochloric acid give any precipitate with ammonia, ammonium sulphide, ammonium carbonate, or sodium phosphate.

Heated in a combustion tube in a current of oxygen, hydrogen, or chlorine, they are unattacked, even when the glass begins to melt.

Heated in a long narrow porcelain crucible in air or oxygen with the table-blowpipe they appear unaltered, but in a shallow uncovered platinum capsule or small porcelain crucible they slowly disappear, without flame; from the platinum capsule the disappearance was complete, but in the porcelain crucible there was sometimes left an almost imperceptible black residue; projecting from this, in one instance, minute fibres were seen with the microscope.

Heated with potassium nitrate in a crucible over a Bunsen burner they are unattacked, but disappear very slowly, without deflagration, when heated with a table-blowpipe.

In density, colour, and streak, and in its chemical behaviour, the residual mineral thus resembles native graphite, but it is considerably harder, and presents itself

in well defined crystals which belong, like the other crystallised form of carbon, the diamond, to the cubic system; terrestrial graphite, when crystallised, is found only as tabular crystals so indistinctly formed that doubt has long existed as to whether they should be referred to the hexagonal or monosymmetric system.

From other fragments of the iron, weighing altogether about 10 grms., thirty more of the cubic crystals were obtained.

Graphitic carbon, sometimes in large nodules, has been found concreted in several meteoric irons, and has been subjected to careful examination by Lawrence Smith;* in structure and powder it is not unlike the compact Borrowdale graphite, and differs completely both from the scaly graphite found native and from that which is presented by certain cast irons; on the other hand, its conversion into graphitic acid by oxidising reagents is more rapid than that of any terrestrial native graphite experimented upon by him.

In a paper entitled "Graphite pseudomorphous after Iron Pyrites," Haidinger,† in 1846, described some graphitic crystals which are doubtless identical in their general characters with those furnished by the Youndegin iron; his observation, however has been forgotten, and is without record in modern meteoric literature. The crystals, of the size, number, and completeness of which Haidinger makes no mention, were obtained by him from a nodule of graphite which had dropped out of the Arva meteoric iron; impressed by the similarity in shape of the nodules of graphite and sulphide of iron present in this meteorite, and by the circumstance that the two minerals are occasionally lying side by side, Partsch conceived the idea that one was pseudomorphous after the other; and Haidinger and Partsch became convinced of the correctness of this idea by the form of the graphitic crystals, on the cube-edges of which they believed there were faces of the pentagonal dodecahedron $\pi \{120\}$, so common a feature of the crystals of iron pyrites. Of the incorrectness of this explanation of the graphitic crystals there can be no doubt; the presence of iron pyrites, crystallised or massive, has even yet not been established for any meteorite; the meteoric sulphide of iron being not the bisulphide but the protosulphide, and having since received from Haidinger himself the specific name of troilite (1863).

Nor is Haidinger's interpretation of the form of the Arva graphitic crystals beyond criticism, for Gustav Rose,‡ to whom the crystals had been kindly sent for inspection, expressed an opinion that the mode of replacement of the cube-edges was suggestive rather of holo-symmetry than of hemi-symmetry—an interpretation which would exclude iron pyrites as a possible antecedent mineral.

The Youndegin graphitic crystals support the view entertained by Rose; the existence of the dodecahedron-face, of which there is goniometrical proof, is of itself quite sufficient to show that the crystalline form is distinct from that of iron pyrites. The iron pyrites theory being abandoned, and the fact being recognised that no mineral constituent of meteorites has yet been found which crystallises in forms similar to those of the graphitic crystals, there naturally arises a feeling of doubt as to the correctness of the view according to which they are of the pseudomorphic origin, and a question as to whether they do not represent a third allotropic condition of crystallised carbon; it is conceivable, in fact, that the explanation by pseudomorphism really resulted from the supposed similarity of the form of the crystals to that of iron pyrites.

Bischof§ denies the possibility of explaining the pseudomorphism of terrestrial minerals by any other process than the slow action of water, of which there is no evidence in meteorites; and though it would be unsafe to argue that only in this way could meteoric pseudomorphs be produced, there is sufficient difficulty in accounting for the occurrence of pseudomorphs in the interior of a mass of iron to compel us to demand strong evidence before the pseudomorphism of the graphitic crystals is granted, more especially when we have regard to the fact that no other graphitic pseudomorph has yet been established either in meteoric or in terrestrial minerals.

The Youndegin crystals were accordingly examined under the microscope with a quarter-inch objective. One of the dodecahedron-faces, an elongated hexagon in shape, showed ridges symmetrical to the truncated edge of the cube, and parallel to the two short edges of the hexagon which met in one of the trigonal quoins. From the faces of several of the crystals spring acutely conical, almost acicular, projections of the same material, more or less irregular in shape; sometimes there is an approximately spherical growth covering a greater part of a cube-face, and occasionally one of the spherical growths is broken, and is seen to be merely a thin, now empty, shell, of which the bottom is the face of the cube; in shape this is suggestive of a burst bubble. One specimen was apparently a fragment of a hollow cube.

The crystals are easily frangible; one of them, when gently pressed between a glass plate and a sheet of paper, was flattened out and was split parallel to the edges of one of the the cube-faces, as if the crystal had been hollow and had collapsed. Examined under the microscope, one of the thin fragments was found to consist of several distinct layers parallel to a cube-face, and on its interior surface was seen a bright triangular face in the zone of a cube-edge; another thin square fragment, doubtless a face of the original cube, has a granulated internal surface, and its edges are bent at right angles to its plane, as if it had formed a portion of a shell. The powder of this crystal was scaly, and gave a scarcely visible streak on the paper. Three other crystals were found to be solid. No cleavage surfaces were visible on the fragments.

The crystals appear to be quite homogeneous in their material.

Although some of these characters point, more or less distinctly, to a pseudomorphic origin of the crystalline form, it cannot be said that they suffice to establish it. The easy frangibility, the absence of evidence of cleavage, the hollowness, and the occasionally crust-like structure, though such as are common in pseudomorphic minerals, are not incompatible with the idiomorphism of these crystals; hollow and skeletal forms, indeed, are frequently a result of a hurried crystallisation, as is so well seen in the artificial crystals of bismuth and of sodium chloride. On the other hand, while the hardness indicates a difference of the material from native graphite, the sharpness, separateness, and completeness of the crystals, the brightness of the faces, the delicacy of the acicular projections, and especially of the obtuse, almost flat, square pyramids on some of the faces, are sufficient to prove that the form has never had any other than its present tenant, and that we have here an allotropic condition of crystallised carbon distinct from both diamond and graphite. And we may add that both of the recognised crystallised forms of carbon have long been standing difficulties for the crystallographer; as already pointed out, crystals of graphite are rarely more than mere tables of which there is a controversy as to the crystalline system, and those of the diamond are so different in their geometrical characters from the crystals of every other known substance that it cannot be satisfactorily determined whether they are to be referred to a holo-symmetric or to a hemi-symmetric type.

If it had been conceivable that the above characters, and the occurrence in the interior of meteoric iron, are compatible with a change in the material since the first development of the crystalline form, it would have been more easy to imagine that the change has been one of molecular re-arrangement than of substitution, and that the crystals were originally cubes of diamond. In fact, the diamond, when in cubes, has faces not very unlike

* *American Journal of Science*, 1876, Ser. 3, vol. ii., p. 388.
† *Pogg. Ann.*, 1846, vol. lxvii., p. 437.
‡ *Beschreibung und Eintheilung der Meteoriten*, 1864, p. 40 *Pogg. Ann.*, 1873, vol. cxlviii., p. 516.
§ *Chemical and Physical Geology*, 1854, vol i., p. 33.

those of the Youndegin crystals, and shows usually a similar bevelling of its edges by rounded faces of tetrakishexahedra. Or, again, it might be argued that during a hurried crystallisation of the carbon, the circumstances, though initially favourable to the formation of diamond, had finally only permitted of the existence of the carbon in a graphitic form.

The nature of the faces, the obtuse pyramid, the spherical growth, the acicular projections, and the parallel groups, are different, however, from anything ever met with in the diamond.

On examination of a large nodule of graphite from the Cocke (or Sevier) county iron, now in the British Museum collection, distinct graphitic crystals, cubo-octohedral in form, were found to be present.

As this kind of crystallised graphitic carbon is unknown among terrestrial minerals, and has so important a bearing on the formation of meteoric graphite, it may conveniently receive a distinctive name, and I therefore suggest the term *Cliftonite*—after Mr. R. B. Clifton, M.A., F.R.S., Professor of Physics at Oxford, who has long interested himself in the physical characters of minerals, and has given great encouragement to their study.—*Mineralogical Magazine.*

MISCELLANEOUS.

Central Institution for Chemical Education.—The Session of the Central Institution of the City and Guilds of London Institute will commence on October 2nd. The Clothworkers, Siemens', Mitchell, and Institute's Scholarships will be competed for at an Examination held on September 25th to 28th. The courses of instruction include Lectures on Mathematics, Engineering, Chemistry, and Physics, and Laboratory and Workshop practice.

The Chemical Laboratory of Wiesbaden.—In the summer term, 1888, there were 65 students on the books. Of these 45 were from Germany, 6 from Russia, 5 from North America, 3 from Italy, 2 from England, 2 from Sweden, 1 from Spain, 1 from Transvaal. Besides the Director, Geh. Hofrath Prof. Dr. R. Fresenius, there are engaged as teachers Prof. Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Dr. E. Hintz, Dr. med. F. Hueppe, and Architect T. Brahm. The assistants in the Instruction Laboratory are two in number, in the private Laboratory 15, and in the Versuchsstation 3. Besides the scientific researches, a great number of analyses were undertaken in the different departments of the Laboratory and the Versuchsstation on behalf of manufacture, trade, mining, agriculture, and hygiene.

NOTES AND QUERIES.

Refractory Stoppers.—The annoyance caused by the stopper becoming fixed in the neck is particularly liable to occur when the bottle contains caustic soda or potash, and after trying several ways to prevent it I hit upon the idea of coating the stopper with a thin film of paraffin wax, and this answers perfectly. The stopper of a bottle containing caustic soda which is in constant use, was treated in this manner about six months ago, and it has never given any trouble since, while before being waxed it was very troublesome in this respect. The idea may not be new, but as I have not seen it mentioned before, it may perhaps be useful to some of the readers of the Chemical News.—C. F. Seymour Rothwell, Manchester, Sept. 3rd, 1888.

TO CORRESPONDENTS.

W. T. B. Ridge.—The information can be found in any good textbook of chemistry.

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NOTICE.

The STUDENTS' NUMBER of the Chemical News *will be published on Friday, September 21st. Gentlemen holding official positions in the Universities, Medical Schools, &c., of the United Kingdom, where Chemistry and Physical Science form a part of the education, who have not yet forwarded the necessary information to our Office for publication in that Number, will confer a favour by sending it with the least possible delay.*

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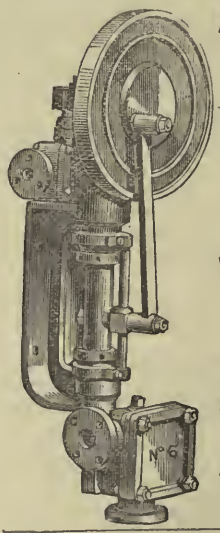

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1503.

ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.*

By Professor WILLIAM A. TILDEN, D.Sc. Lond., F.R.S., F.C.S., President of the Section.

A part of the duty which devolves upon the President of a Section of the British Association consists in delivering an address, and the knowledge that a pretty full liberty of choice is permitted in regard to the selection of a subject is the only source of comfort which serves to alleviate the onerous nature of the task.

It seemed to me that the time is gone by when an attempt to review progress over the whole field of chemical science is likely to be useful or even possible, and an account of what is being done within the narrow limits of those parts of the science to which I have been able to give special attention would be ill-adapted to the character of a speech addressed to the members of the Section collectively. The fact that at the last meeting of the Association a Committee was appointed to inquire into the methods at present adopted for teaching chemistry suggested that, as I had not been able to accept an invitation to join this Committee, I might make use of this opportunity for contributing to the discussion. The first report of the Committee will be received with much interest by the Section. As might be expected, it embodies the expression of many varieties of opinion.

The existence of chemistry as a department of science, not merely requiring the observation of facts that are to be made useful, but seeking in the accumulated stores of observation to discover law, is a thing of comparatively recent growth. How chemistry arose out of alchemy I need not remind you, but the connection between the study of chemistry and that of medicine, and the maintenance of this connection down to even the present generation, is illustrated by the fact that a large number of men who have become eminent as chemists began their career in the surgery or the pharmacy. Black, Davy, Berzelius, Wollaston, Wöhler, Wurtz, Andrews, and W. A. Miller began by the study of medicine, whilst Scheele, H. Rose, and the great names of Liebig and Dumas are to be found in the long roll of those who received their earliest notions of chemistry in the pharmaceutical laboratory. Chemistry has been gradually emancipated from these associations with enormous advantage to both sides. So long as technical purposes alone were held in view a scientific chemistry could not exist, but no sooner did the study take an independent form and direction than multitudes of useful applications of the facts discovered became apparent.

It is only within a comparatively few years, however, that universities, in this country at least, have ceased to deal with chemistry as a kind of poor relation or humble follower of medicine, and have permitted her to emerge from the cellars of a museum or school of anatomy, and have given her a commodious dwelling in the fair light of day.

In the old time such instruction in chemistry as was given in the universities and mining or technical schools seems to have taken the form of lectures read by the Professor, and access to a laboratory for practical manipulation seems to have been a high privilege accorded only under exceptional circumstances to the few. We are told, for example, that when Liebig went to Paris in 1823 he applied to Gay-Lussac for practical instruction at first without success, and that admission to the laboratory of the Ecole Polytechnique was ultimately granted him only through the intervention of Von Humboldt.

In a great many cases the student of chemistry must have been almost entirely dependent upon private study, though books were scarce and materials more costly than now. Davy, for example, seems to have had no instruction whatever previous to his appointment as assistant to Dr. Beddoes at the Pneumatic Institute at Bristol.

Doubtless, therefore, the recollection of his own early difficulties when seeking instruction contributed largely to influence Liebig in the establishment of the laboratory in the University of Giessen, and in the adoption of the principles which guided his teaching there. For the first time in the history of chemistry students met not merely to listen to the discourse of a professor concerning his own experiments and conclusions, but to examine for themselves the basis of the theories taught, to learn the processes of analysis, and by independent investigation to extend the boundaries of existing knowledge.

The fame of the new school spread fast and far, and soon men from every part of the civilised world assembled to share in the advantages offered. The influence of the new method can be estimated when we reflect that nearly all the now passing generation of chemists in England and America obtained the greater part of their training in Liebig's laboratory; and as a large number of them have been teachers, it may be assumed that they transplanted into their own countries the methods they had learnt from the great German master.

It was not till 1846, long after the school at Giessen had risen into fame, that in England a sense of our deficiences in respect to provision for teaching chemistry was felt strongly enough to lead to the establishment of a college of chemistry. At that time the Professor of Chemistry at Oxford was also Professor of Botany. At Cambridge it was thought praise and boast enough that the occupant of the chair of chemistry had, during more than thirty years, frequently resided at the University and every year gave a course of lectures. The Jacksonian professorship was not then, as now, in the possession of a chemist. University College, London, had at this period a very distinguished man in the chair of chemistry, but it was only in 1848 that a commodious laboratory was provided by public subscription, raised in commemoration of the services of Dr. Birkbeck in promoting popular education. In that year Fownes was appointed to co-operate with Graham in the work of teaching, though his premature death soon after left but little time for the fulfilment of the rich promise of his earlier years. At Manchester John Owens had died in 1846, leaving the bulk of his estate for the purpose of establishing a university in Manchester, but as yet the Owens College was not.

The foundation of the College of Chemistry in 1846 was therefore an event of supreme importance in the history of chemical teaching in this country; and though at the time some dissatisfaction was expressed at the choice of the professor selected to direct the work, who, though a distinguished pupil of Liebig, was not an Englishman, all British chemists now concur in believing the choice to have been a most fortunate one. The great majority of my contemporaries having begun, continued, or ended their studies in Oxford Street, they and all who have come under Dr. Hofmann's teaching know how vast was his capacity for work and how marvellous was the power he possessed of communicating his own enthusiasm to his pupils.

Since the time of which I have been speaking the means of instruction in science in England have multiplied enormously. In University College, London, founded in 1828, and in Owens College, Manchester, founded in 1851, not only have chairs of chemistry existed from the first, but they have been occupied by a succession of chemists of the highest eminence. But long after 1846 the whole of the serious teaching of scientific chemistry was accom-

* Read Thursday, September 6, 1888.

plished at the College of Chemistry, and it was nigh upon twenty years before the Manchester school began to attract considerable notice.

In 1872-3 the movement set in which has resulted in the erection of colleges for higher instruction at a number of important English and Welsh towns. These, together with the pre-existent Queen's Colleges in Ireland and the Universities of more ancient foundation in the three kingdoms, are for the most part provided with pretty good laboratories and a competent staff. We have also the Normal School of Science and the Institute raised by the City and Guilds of London at South Kensington, and its Associate College at Finsbury. England is therefore at the present time as well provided with *places* of instruction for the study of chemistry as any country in the world.

And a very large proportion of the professors or heads of the chemical schools in the colleges and universities of the United Kingdom have shown by their own activity in research that they are qualified to give instruction of the highest kind, and are ready to train young chemists in the art as well as in the theory of their subject.

It is therefore no longer true that a student desiring to become a scientific chemist must needs choose between a single institution in London and another in Manchester, or must seek the instruction which he cannot get at home in the laboratory of a foreign university. As an element in a liberal education, the position of chemistry is also considerably in advance of what it was twenty years ago.

It is nevertheless true that increased opportunities for study, a considerable supply of capable teachers, and an enormous body of students have not produced such an amount of original investigation, or even of accurate analytical work, as might reasonably be expected. A full and complete explanation of all the influences which contribute to this result would be difficult; but I think the apparent inactivity of the chemical schools in this country is not generally the fault of the professors, but is chargeable in the main to the ignorance and partly to the indifference of the public. There exists as yet no intelligent feeling in favour of learning, nor indeed in favour of any sort of education, unless there is expectation of direct returns in the form of obvious practical results. It is this which animates the present popular movement in favour of so-called "technical" education. That part of the attention of the nation which can be spared from the contemplation of Irish affairs is concentrated upon the problem of how to make every little boy learn the rudiments of chemistry, whether he likes it or not, whilst there are comparatively few people interested in the question of how to provide means and instruction for those who are capable and desirous of attaining to a mastery of the subject. Moreover, the public have not yet grasped this truth, that, so far as chemistry is concerned, it is of very little consequence to the great metallurgical and chemical industries whether the workpeople do or do not know a little chemistry, though it is important that they should be intelligent enough to obey orders. What is wanted is that every manufacturer and manager should himself be an accomplished engineer and chemist, trained to observe, to reason, and to solve problems for himself.

In the case of chemistry this absence of sentiment in favour of concentration and thoroughness, and the demand for superficiality, if only it can be had wholesale, tells in a variety of ways. The governing bodies who control the various colleges and universities, and the public generally, cannot understand that good and useful work is being done unless it can be shown in the form of passes at examinations. Though I most firmly believe in the necessity for examinations serious mischief begins when they are regarded as the end itself, and not as mere incidents in the student's career towards the end, which should be knowledge.

In respect to chemistry this is the disadvantage which attends the operation of such a system as that of the Science and Art Department, or of any system under which certificates in connection with individual subjects are granted on easy terms. Especial objection I also feel to such expressions as "advanced," used in reference to a particular stage, so commonly misunderstood as they are by the student and his friends, and operating against his further progress.

Reflect also upon the fact that there are only two or three colleges in this country which can boast of more than one professor of chemistry. In nearly all cases one man is called upon to discharge the duty of teaching classes, both elementary and advanced, in pure and applied chemistry, inorganic and organic, theoretical and practical. This is a kind of thing which kills specialism, and without specialists we can have not only no advance, but no efficient teaching of more than rudiments.

That teachers ought to engage in research at all is by no means clear to the public and to those representatives of the public who are charged with the administration of these new institutions. This was illustrated very painfully a few years ago by the conditions under which professors were engaged at a certain college founded, according to the declaration of its promoters, "by the people for the people," wherein it was announced in round terms that original research was not wanted, as the college was "for the good of the many and not for the advantage of the few." This example of ignorance is only remarkable by reason of its audacity. Probably many people hold a similar view, though few are bold enough to declare it.

Without going far into the discussion of the general question, which is a large one, I may perhaps be allowed to offer a few remarks for the consideration of any of my audience who may perchance incline towards that opinion.

It is only when a teacher occupies himself with research that the most complete guarantee is given that he is interested in his subject, and that he is a learner. A popular mistake consists in regarding a professor as a living embodiment of science — complete, infallible, mysterious; whereas in truth he is, or ought to be, only a senior student who devotes the greater part of his time to extending and consolidating his own knowledge for the benefit of those who come to learn of him, not only what lies within the boundaries of the known, but how to penetrate into the far greater region of the unknown. Moreover, the man who has no intellectual independence and simply accepts other people's views without challenge is pretty certain to make the stock of knowledge with which he sets out in life do service to the end. That one may be fitted to form a sound judgment concerning new theories, he must be familiar with the methods by which progress is accomplished. The work of investigation then re-acts beneficially upon the work of teaching; that is why teachers should be encouraged, nay even required to investigate, and not because their discoveries may haply prove to be practically useful.

Of course it may be said that there have been distinguished investigators who could not teach, but the converse is not true; every teacher who has attained to eminence as a teacher, who has drawn men after him, who has founded a school of thought, and has left his mark upon his generation, has been an industrious worker in research of some kind. All teachers cannot be expected to reach the same high standard, but this is the ideal after which all must strive, or fail utterly.

The fact that there is as yet little demand among schoolmasters for high attainments in chemistry is another reason why so little is accomplished in the chemical schools. Here again the public is really to blame. It is disgraceful that in all classes of schools, even where chemistry is supposed to be taught, there are but few places where serious employment is found for the well-trained chemist. I could point to several schools which claim the position of first-rate, where chemistry is taught by masters who have never studied the subject at all, but who are, I suppose, allowed the traditional "ten

minutes' start" with the book. Would the head-masters of such places dare to employ a person to teach mathematics who did not know the four first rules of arithmetic, or another to teach Latin who had not even got through the accidence? I fancy not. This, however, is, without exaggeration, the exact parallel of the position in which chemistry is placed in the majority of schools. I have heard the excuse that there is a lack of competent teachers. Of course the demand and the supply will re-act upon each other. When you offer a reasonable stipend, reasonable accommodation for teaching effectively, reasonable leisure for the master's own studies, and a position on the staff not inferior to that of the classical and mathematical masters, I believe that then, but not till then, there will be as many good school teachers of chemistry as there are of other subjects.

I could point to other prominent schools where the chemistry and other branches of science are taught by a peripatetic South Kensington teacher, who arrives weekly with his box of tricks. Not long ago I was invited to distribute the prizes given in connection with the evening classes in a town not far from Birmingham, and I took the opportunity of advising the teachers present on the occasion to read. One of them said to me afterwards, "When do you suppose I can read? I am engaged in going round to my schools from nine in the morning till ten at night." People of this kind do the greater part of the so-called science teaching sustained by the Science and Art Department, and the worthy town councillors and committees who employ them think that these are the people who are going to help the British manufacturer in his struggle against foreign competition under the guidance of the highly-trained chemists from the German universities. This would be ludicrous if it were not so very serious.

There is an opportunity at the present time of correcting some of these mistakes, but no advantage is being taken of it. I refer now to the "technical schools" which are springing up everywhere. There may be a few competent teachers of chemistry employed in some of them, but I find it difficult to think of many examples. The sort of person who is put in charge of these places is usually a schoolmaster, who is allowed, sometimes even after his appointment, to get a short course of qualitative analysis in order to enable him to obtain a certificate which will entitle him to earn grants from the Science and Art Department.

And manufacturers are much to blame. Instead of employing trained chemists the greater number of those who want chemical assistance are satisfied to engage the services of boys who have been to an evening class for a winter or two.

The difficulty of finding a satisfactory career in connection with the subject also accounts for the fact which I fear must be admitted, that chemistry does not attract its due share of the intellect of the nation. Clever young men can usually do better at the law, in medicine, or in commerce, than in teaching chemistry or in manufactures in which chemical skill is applicable. So badly educated are many of the young men who commence the study with professional objects in view, that it is quite impossible to teach them anything beyond routine analysis, if so much.

I heard lately from a friend of mine a story of a young groom in his employ who cannot read or write—and who declines to be taught to read on the ground that, considering himself pretty smart, he is afraid that "learning might dull him." This idea seems to be rather prevalent among certain classes of people, but I can assure those who wish to be chemists that some familiarity with the rule of three, and such a command of English as will enable them to understand words of more than one syllable, will be no obstacle to the acquisition of chemical knowledge.

Three years has hitherto been regarded as the normal period for study. The question arises, can a young man, previously well educated, expect to become an accomplished chemist, competent to apply his knowledge usefully, by giving the whole of his time to study during *three years*? I believe not.

By reason of the enormous development of the science the position of the student of chemistry is nowadays very different from what it was thirty years ago. Since that time we have not only got a few new elements, a matter of small importance in itself, but new views of the nature of the elements and of their mutual relations. This could hardly have come about but for the recognition of the law of Avogadro as a fundamental principle, upon which we rely as the ultimate criterion by which the true distinction between so-called equivalent weights and molecular ratios has been established. By the gradual evolution of ideas having reference successively to the electro-chemical relations of elements and compounds, the theory of types, and atomicity or valency, we have arrived at notions of chemical constitution based upon the hypothesis of the orderly linking together of atoms. Thirty years ago isomerism had scarcely attracted notice, and carbon compounds were only just beginning to be arranged in homologous series. The general use at the present day of the language of the molecular kinetic theory shows how deeply this theory influences our ideas of the internal constitution of matter. Within the period referred to, dissociation has been studied, and a vast body of thermo-chemical data have been accumulated. And although the larger portion of the results of this work still await interpretation, dynamical ideas of chemical action are now generally accepted. We have also new methods of investigation, including spectroscopic analysis with all its vast train of results.

When I began chemistry many of these subjects and others had not been heard of. Of course we had our difficulties, and I well remember the puzzles met with in the endeavour to refer compounds to their appropriate types, also the consternation caused in the student's mind and the confusion in his note-book by the successive changes in the atomic weights of carbon, oxygen, sulphur, and the metals. But on the whole there was much less to learn.

It has always been thought essential that a student of chemistry should have some knowledge of physics. It is now more than ever necessary that this knowledge should be extensive, sound, and based upon a good foundation of mathematics. Thirty years ago a hundred pages of Fownes contained all that was thought necessary, but no one nowadays could be satisfied with that. It is now asserted that a young chemist who expects to find a career in industrial chemistry should also have learnt drawing, and more important still that he should have a good general knowledge of mechanics, steam, and building construction. I suppose everyone will agree in adding French and especially German. You see how the requirements expand.

The inference from all this is that it now takes longer to make a chemist than formerly. This is a point of considerable practical importance.

My estimate that a well-educated and intelligent young man will now require five yeas for the study of chemistry and accessory subjects before he is likely to be of much use will not appear extravagant.

Here one may remark that in order to become a chemist it is before all things nec sary to study chemistry. If the greater part of a student's time is to be taken up with other things it is not very clear how this is to be done.

A reform all round is wanted. The mathemetics, modern languages, and drawing properly belong to the antecedent school period, and I believe the Institute of Chemistry would greatly promote the interests of the profession if it would impose upon candidates for the Associateship not only a three years' course of training with an examination in practical chemistry at the end, but a severe examination in mathematics, in the English, French, and German languages, and perhaps drawing before matriculation or registration.

A consideration of the present position of the student

of chemistry leads naturally to a review of the methods of teaching the subject. Speaking broadly, I suppose nearly all professional chemists who have had the advantage of systematic training have, up to the present time, passed through very much the same kind of course. This consists, as everybody knows, very largely of analytical work, qualitative and quantitative, preceded or followed by the preparation of a number of definite chemical compounds, besides practice in certain very necessary physical determinations, *e.g.*, relative density of solids, liquids, and gases, melting points, boiling points, and so forth. There seems now to be a disposition in some quarters to depart from this time-honoured curriculum in favour of a course in which the student is early engaged in some semblance of investigation, and in which he is encouraged to attack difficult problems, which from their fundamental importance offer considerable temptation. I venture to express a hope that this will not be carried too far. Already we are in danger of losing the art of accurate analysis. One constantly meets with young chemists who are ready enough to discuss the constitution of benzene, but who cannot make a reliable combustion. And according to my own experience attempts at research among inexperienced chemists become abortive more frequently in consequence of deficient analytical skill than from any other cause.

One modification I should gladly see generally adopted. I think an unnecessary amount of time is often spent upon qualitative mineral analysis, and an acquaintance with the properties of common and important carbon compounds ought to be acquired at an early stage. Quantitative work might with advantage be taken up much sooner than usual. By that, however, I mean serious work in which good methods are used and every effort made to secure accuracy. I do not believe in the use of rough methods, because they are easy; the use of such leads the student to be satisfied with approximations, which after all he will learn soon enough is all that is possible to man. I am very glad to know that I have the support of one of my predecessors in this chair (Sir Henry Roscoe), whose opinion will carry far greater weight than mine in deprecating premature efforts to engage students in research.*

But though it does not appear to me to be wise to encourage beginners, without sufficient experience or manipulative skill, to attempt original work, one of the best possible exercises preparatory to original work is to select suitable memoirs, and not only to read them but to work conscientiously through the whole of the preparations and analyses described, following the instructions given. Many of Dr. Hofmann's papers afford excellent examples. So also do the writings of Dr. Perkin and Dr. Frankland, besides those of many other chemists which could easily be selected by the teacher.

An intelligent student, possessing the requisite preliminary knowledge, would obtain much instruction by repeating the work contained in such papers as the following, for example:—Emerson Reynolds on the missing Sulphur Urea (*Journ. Chem. Soc.*, 1869—i.); Fittig and Tollens on the Synthesis of Hydrocarbons of the Benzol Series (*Liebig's Annalen*, 1864, cxxxi., 303); L. Claisen and Pupils on the introduction of Acid Radicles into Ketones, &c. (*Berichte*, xx.); Lawson and Collie on the Action of Heat on Salts of Tetramethyl-Ammonium (*Journ. Chem. Soc.*, June, 1888); Thorpe and Hambly on Manganic Trioxide (*Journ. Chem. Soc.*, March, 1888); besides many others, including papers on analytical processes. To such as these there might subsequently be added the determination of an atomic weight on the model of one of the best masters, as a discipline which could not fail to be impressive, and full of instruction.

When chemistry is taught, not with professional or technical objects in view, but for the sake of educational effects, as an ingredient in a liberal education, the primary object is to make the pupil observe and think. But with young students it is very important to proceed slowly, for chemistry is really a very difficult subject at first, owing to the variety of strange materials with uncouth names. To reason from particulars to generals is for the unpractised always a difficult process, and in chemistry this is specially the case. With young students it is, in my experience, preferable to adopt a somewhat dogmatic style, which should of course be exchanged for a more cautious one as the pupil proceeds.

Thus the law of Avogadro can only be given at first as a recognised physical law, without much explanation, since the full apprehension of the evidence upon which it rests can only be secured at a late stage of the learner's progress. There is of course great advantage in the use of an inductive method if only it is employed judiciously. Otherwise the result is only confusion.

A number of papers, pamphlets, and text-books have lately appeared, professing to teach the principles of the science practically and by new methods. Most of these turn out, upon inspection, to be very old methods indeed, but there is a small residue of distinctly original character which are sure to attract, as they deserve, considerable attention. The systems I refer to provide a series of problems which the pupils are called upon to solve. According to this plan the student is not allowed peaceably to examine the properties of oxygen or sulphur which he now sees for the first time. He must weigh, and measure, and observe, and then infer. All this coming at once upon the head of a beginner seems to me to be well fitted to drive him to despair.

I well remember the first experiment in chemistry I ever made. It consisted in dissolving zinc in diluted sulphuric acid in an evaporating dish, lighting with a match the bubbles of hydrogen as they rose, and afterwards leaving the solution to crystallise. I was about sixteen, and the bubbles of gas as well as the crystals I afterwards got interested me very much. If at that time I had been made to weigh the zinc and acid, and measure the hydrogen with the object of answering some question about the composition of zinc and hydrogen sulphates, I should have been pretty much in the position of a boy ignorant of geometry shut up with the propositions of Euclid and ordered to give the demonstrations.

I think when we recall such a fact as that Priestly, who discovered oxygen in 1774, failed to the end of his days to understand the process of combustion, and actually wrote, in 1800, a pamphlet in defence of "phlogiston," we ought not to be surprised when young people, though born a century later, fail to perceive at once the full significance of facts to which they are introduced for the first time. At the outset you cannot reasonably expect a young student both to observe accurately and infer justly. These two things must be kept separate at first, and for this reason among others I believe that attempts to make young students verify for themselves the fundamental propositions of chemistry will not be successful. One has only to trace the origin of one's own convictions in reference to any important fact or principle to perceive that they very seldom spring into existence suddenly, but almost always commence in vagueness and hesitation, acquiring consistency and solidity only as the result of accumulated experience.

I will not pretend to determine what may be included within the wide circle of the functions of the British Association; but I think I cannot be mistaken in assuming that the advancement of science is dependent in no small degree upon the provision for the efficient teaching of science. I have traced an outline of what has been done in the past, and have endeavoured to show in what respects I think we are deficient at the present time. No matter how ardent may be the aspirations, how earnest the endeavours of the few, progress will be slow unless they are sustained by the sympathy of the many. On one principle the public must surely insist, that only those shall be allowed to teach who know.

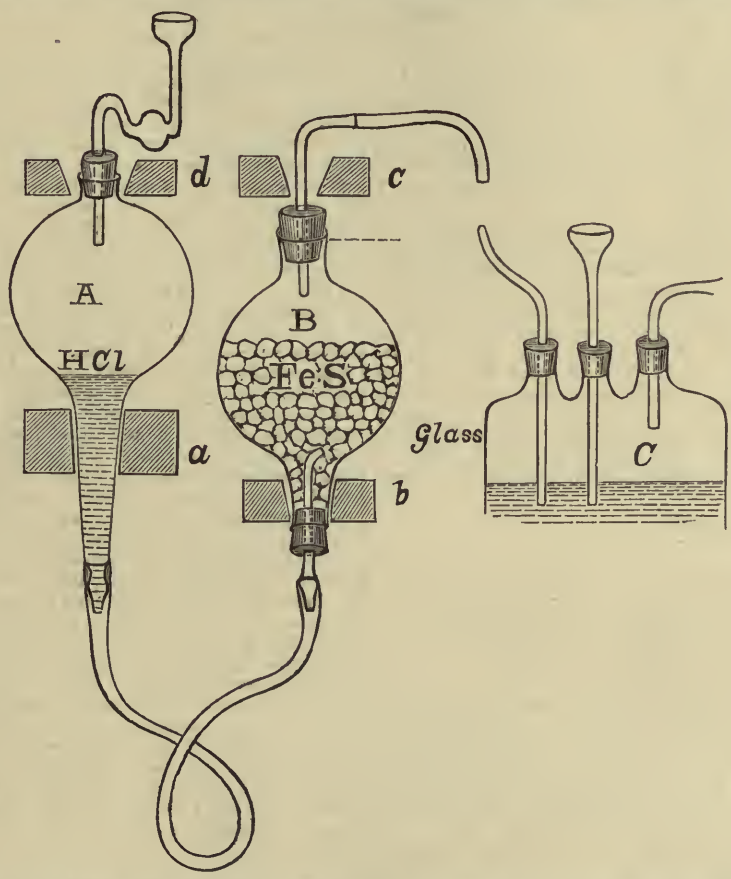
* See Address to Section B, Montreal meeting.

APPARATUS FOR GENERATING SULPHURETTED HYDROGEN OR HYDROGEN GAS.

By JOHN H. J. DAGGER, F.I.C., F.C.S.

This form of apparatus, which has been in use for some time past in my laboratory, consists of a glass vessel, A, containing dilute HCl, and is connected with the generator, B, by a flexible caoutchouc tube which may be any convenient length.

The lower tubulure of B is closed by a caoutchouc stopper, through which passes a piece of glass tubing about 8 c.m. long; the flexible tube is slipped over the end of this and bound by a few turns of fine platinum wire. The lower part of B is filled with large pieces of glass or small glass marbles to about ½ inch above the end of the acid tube—above this layer is the Fe″S or granulated *Zn*, as the case may be, in pieces small enough to pass through the upper tubulure of B, which is closed by a caoutchouc stopper, through which passes the delivery tube, which may be connected with the ordinary washing apparatus.



The vessels, A and B, are supported by wooden forks, *a*, *b*, *c*, *d*, arranged at different heights, and fixed to the side of the H_2S cupboard—for lecture purposes suitable stands with screw clamps to admit of either vessel being raised or lowered would be used.

By altering the levels the flow of gas can be stopped or regulated. By simply disconnecting the delivery tube the bulbs may be removed together and cleansed or recharged in a few minutes.

A cheap form of the apparatus may be readily constructed with two lamp glasses.

The Phœnix Smelting Works, Neath.

ELECTROLYTIC METHOD OF LIQUEFYING GASES.

By H. N. WARREN, Research Analyst.

The usual method of liquefying a gas such, for instance, as chlorine, sulphur dioxide, &c., is, as is well known, prepared either by the action its own pressure exhorts when evolved in a confined space, or by intense cold, or thirdly by a combination of both. A brief description of the electrolytic method will therefore suffice to explain the strong analogy that exists with respect to both methods, save that at present the latter method is better adapted when a compound gas is desired, such, for instance, as HCl, &c. The apparatus employed consists solely of a stout glass combustion-tube, bent at right angles, and closed at either extremity, the longer limb containing two small platinum plates fused into the extremity of the tube, the bend of the tube containing a small plug of asbestos, soaked or saturated with strong H_2SO_4 for the purpose of retaining moisture. For the preparation of liquid HCl a sufficiency of a strong solution of HCl is first introduced, covering the platinum plates, and the asbestos plug inserted in the bend of the tube. The other extremity, being accurately sealed, is introduced into a freezing mixture of ice and salt. To

the outer extremity of the platinum plates, which should, for convenience sake, terminate in the form of wire, is connected a voltaic battery capable of quickly decomposing the acid. Large volumes of hydrogen gas, together with chlorine gas, are at once evolved, and becoming confined in the smaller end of the tube, aided by the low temperature produced by means of the freezing mixture, the gaseous HCl rapidly assumes the liquid form, the liquid thus produced being generally possessed of a decided yellow tint, due to the presence of free chlorine. If now the tube and its contents are withdrawn from the freezing mixture and the circuit discontinued, the liquid gas is quickly re-absorbed by the water, forming the original solution, which experiment may again be performed as before; a number of the various other compound gases may also likewise be obtained.

An interesting reaction is also afforded when acidified water is substituted in place of the HCl solution, the condensing part of the apparatus being also provided with a very thin platinum plate, to the surface of which is attached some platinum black. On connection with the batteries being thus completed, the usual decomposition of the water takes place, and the liberated gases, owing to the intense pressure they are exposed to, together with the surface action that is afforded, and peculiar to that metal, explode at intervals, each time generating small quantities of water, which was found, on examination, to contain large quantities of H_2O_2, besides retaining a peculiar ozonised odour.

The above reaction may be made altogether more striking, and affords an excellent lecture experiment when a small quantity of water containing a few drops of chromic acid, to which a quantity of ether has been added, sufficient to form a layer on the surface, the ether quickly assuming a deep blue colour, due to its absorption of the well-known blue oxide of chromium. By substitution of the acidified water various other compounds, such, for instance, as acetylene, may be readily formed. For the liquefaction of hydrogen and oxygen gas, a modified wrought-iron condenser has been constructed, but hitherto the results have been only partially successful, although, in more than one instance, hydrogen gas has been decidedly liquefied.

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NOTE ON BARIUM SULPHITE.

By E. RATTENBURY HODGES.

Many text-books state that barium sulphite is soluble in hydrochloric acid. Having occasion recently to test a sample of sodium sulphite for traces of the sulphate, with barium chloride in the usual way. I found the precipitate did not dissolve in HCl. This result evidently pointed to the presence of a sulphate, but still it seemed worth while to try the point in other ways.

(1). To a solution of $BaCl_2$ I added a solution of sulphur dioxide, and obtained a white precipitate, also insoluble in HCl, whether dilute or strong.

On boiling, the precipitate remained undissolved; but in this case it seemed likely that some sulphuric acid had come over with the sulphur dioxide (for the latter had been prepared by reducing H_2SO_4 with copper), and that the test was therefore unreliable.

(2). Sulphur dioxide gas, obtained by warming crystals of sodium thiosulphate with strong HCl, was passed into a fresh solution of barium chloride, and the result was the same, a precipitate of barium sulphite insoluble in HCl.

(3). Another sample of sodium sulphite in crystals was warmed with HCl, and the gas thus evolved was passed into $BaCl_2$. In this case also, on the addition of HCl, the precipitate did not dissolve.

All the precipitates which were left in the presence of HCl remained undissolved after ten hours' standing. Both samples of sodium sulphite gave an alkaline reaction with test-paper.

Suspecting now the hydrochloric acid, I tested it for sulphuric acid, but found no traces.

The above results make it appear tolerably conclusive that barium sulphite is not soluble in hydrochloric acid, the chemical text-books notwithstanding.

Nottingham, August 28, 1888.

DETERMINATION OF TRACES OF ARSENIC IN TISSUES, YARNS, AND PAPER-HANGINGS.

By R. FRESENIUS and E. HINTZ.

In endeavouring to convert the so-called Swedish process for the examination of arsenical textile substances into a quantitative method, the authors have proceeded as follows, with good results.

Twenty-five grms. of the tissue in question were cut up and introduced into a tubulated retort of Bohemian glass holding about ½ litre, and covered with ¼ litre of hydrochloric acid of sp. gr. 1·19. The neck of the retort was then bent at an obtuse angle, and it was placed so that the part of the neck next the body was turned obliquely upwards, and the other part obliquely downwards. The latter part was connected with a condenser, the tube of which led air-tight into a tubulated receiver of 700 to 800 c.c. The receiver was charged with 200 c.c. water and was plunged in a larger vessel of water in order to keep it cool. A Peligot tube containing a little water was also connected with the receiver by its tubulure.

After thus digesting the material for one hour, 5 c.c. of an aqueous solution of ferrous chloride (saturated in the cold) were introduced into the retort; the glass stopper was fixed air-tight in the tubulure by means of vaseline, and a gentle heat was applied by means of a Maste lamp. After the excess of hydrochloric acid gas has passed over the temperature is raised so that the liquid boils, which is continued until strong frothing puts a stop to the distillation. More than two-thirds of the liquid in the retort could generally be distilled over. When cold, 100 c.c. of hydrochloric acid at 1·19 are added to the contents of the retort and distilled off as far as possible. In this second distillate only very trifling quantities of arsenic are present. Both the distillates, which are coloured brown by organic substances, are mixed with the contents of the Peligot tube, and diluted to 800 c.c. Into this liquid sulphuretted hydrogen is passed, warming gently at first, and afterwards in the cold, and it is let stand for twelve hours. The precipitate, along with arsenic sulphide, contains relatively much organic matter which must be eliminated. For this purpose the precipitate is collected upon an asbestos filter, prepared by placing asbestos in a funnel fitted with a glass cock. After the precipitate has been washed the cock of the funnel is closed and the precipitate in the funnel is treated with bromo-hydrochloric acid, prepared by dissolving bromine in hydrochloric acid of 1·19. The funnel must be covered with a glass plate. After this acid has acted for a sufficient time the cock of the funnel is opened and the solution is let flow down into the precipitation flask, to the sides of which some small portions of the precipitate often adhere. To avoid, as far as possible, dilution of the acid, the asbestos filter is previously washed with hydrochloric acid of 1·19. The liquid in the flask is mixed with an excess of ferrous chloride, and its contents are rinsed with hydrochloric acid as before into a smaller retort of a distillation apparatus otherwise similar to the above. The contents of the retort were then distilled off to a very small residue, so that in general a single distillation conveyed all the arsenic into the distillate. The contents of the receiver and of the Peligot tube, on re-treatment with sulphuretted hydrogen, yielded pure arsenic trisulphide. This was

collected upon a filter, dried at 110°, washed first with water, and then successively with absolute alcohol, carbon disulphide, and again with alcohol, in order to remove free sulphur. The whole is then weighed after drying at 110°. All the reagents and the glass vessels must be subjected to a blank experiment in order to prove the absence of arsenic.

The method is available for the examination of colouring-matters.—*Zeitschrift für Analytische Chemie* (vol. xxvii., p. 179).

SEPARATION OF LEAD AND BISMUTH.*

By HERMAN HERZOG, Jun.

The author made a series of experiments testing the principal methods for separating lead from bismuth.

1. Equal parts of both metals in solution as nitrates were treated with a slight excess of sulphuric acid and then heated until all nitric acid had been expelled, after which the solution was evaporated to complete dryness. Then dilute sulphuric acid (1·10) was added and, after digestion, the residue was filtered and washed with dilute sulphuric acid. A series of ten experiments showed that from 1·97 per cent to 2·79 per cent of the bismuth remained with the lead—the mean of the ten experiments being equal to 2·51 per cent.

2. A similar solution was evaporated in a like manner until fumes of sulphuric acid went off copiously and the mass had changed into a solid cake. It was then treated with acid as before. Ten experiments showed that from 1·05 to 1·31 per cent of the bismuth (or a mean of 1·17 per cent) remained with the lead.

3. Similar solutions were evaporated as before until fibrous crystals of bismuth sulphate appeared and fumes of sulphuric acid began to be evolved—then diluted with water and dilute sulphuric acid, &c. In ten experiments only 0·19 to 0·41 per cent of the bismuth remained with the lead. (The mean was 0·28 per cent). The latter method is the one generally made use of in the laboratory of the University—however, in order to recover the small amount of bismuth the lead sulphate is dissolved in hot sodium hydrate, from which solution it is subsequently precipitated by sulphuric acid. The minute residue left behind is dissolved in dilute nitric acid, evaporated with an excess of sulphuric acid, filtered, washed, and the solution added to the main filtrate from the lead.

Nine series of five experiments each, which the author made, showed that the strength of the sulphuric acid used in washing was of great influence on the accuracy of the determinations. His results were:—

Strength of Acid.	Bi_2O_3 left in the $PbSO_4$.	PbO found with Bi_2O_3.
1 : 4	0·009	7·54
1 : 5	0·019	6·05
1 : 7	0·072	0·51
1 : 8	0·172	0·30
1 : 9	0·51	0·07
1 . 10	0·79	trace
1 : 15	1·11	,,
1 : 25	2·91	,,
water	3·21	0·13

Equal quantities of lead and bismuth were taken.

The addition of alcohol has proved to be of no advantage, and is recommended merely to remove the sulphuric acid from the lead sulphate precipitate after washing.

It was found that the addition of hydrochloric acid before precipitating the lead as sulphate is of no advantage; on the contrary, notwithstanding the greater solubility of the lead chloride, it is difficult to convert it into sulphate, the precipitate being often more chloride than sulphate even after standing for one day. Then also the bismuth, when precipitated in the filtrate by ammonium carbonate, contains oxychloride which on ignition will cause some of the metal to volatilise.

Experiments made to separate bismuth from lead as oxychloride gave from 2 to 5 per cent of the lead with the bismuth; on re-dissolving and re-precipitating the bismuth contained only traces of lead.

The method of separating bismuth from lead as basic nitrate gave unsatisfactory results; *with bismuth alone* the average of ten analyses showed 99·89 per cent of bismuth (maximum loss being 0·23 per cent, minimum, 0·09 per cent). If in presence of lead the evaporation is not carried far enough, bismuth will go in solution, whilst if carried so far as to render it insoluble from 8 to 11 per cent of lead may be retained.

Liebig's method of precipitating bismuth by barium or calcium carbonate gave low results and was otherwise unsatisfactory.

In Ullgren's method of precipitating bismuth by metallic lead the excess of acid in the solution of the nitrates was removed by evaporation, after which the solution was supersaturated with acetic acid and a weighed strip of lead was kept immersed for twenty-four hours. The spongy bismuth was washed off, if necessary, removed with the aid of a feather, and collected in a weighed button of fusible alloy and weighed. The lead was determined either as a sulphate or chromate, and the amount lost by the lead strip deducted from the calculated amount. The following results were obtained:—

Amount in Grms.

	I. Taken.	I. Found.	II. Taken.	II. Found.
Pb	0·5523	0·5531	0·5619	0·5621
Bi	0·2310	0·2314	0·1921	0·1922

	III. Taken.	III. Found.	IV. Taken.	IV. Found.
Pb	0·6310	0·6314	0·1020	0·1018
Bi	0·0820	0·0822	0·5200	0·5208

Abel and Field's method of adding copper hydrate, or basic copper nitrate, to the solution which was nearly neutralised with ammonium hydrate, and then warming, gave good results, although somewhat high in bismuth. In twenty determinations the maximum deviation was not over 0·20 per cent above the amount of bismuth taken, and this can be reduced to a minimum by repeating the operation. The principal difficulty lies in the separation of the copper oxide from the bismuth oxide by ammonium hydrate, which should be repeated; the lead may be separated from the copper by ammonium carbonate or by precipitating it from an *acetic acid* solution as chromate.

The volumetric methods tried were all found to be more or less complicated and liable to error. The well-known chromate method gives very fair results. The method recommended by Haswell is to add sodium hydrate (or zinc oxide) to a nitric acid solution until a slight precipitate remains on standing; then to heat the solution to 60° C. in a porcelain vessel and to run potassium permanganate into it until the supernatant liquid remains pink after a few minutes standing. The results obtained were, on an average, about 0·7 per cent too high. Of all the other volumetric methods none gave even approximate results.

A method which has not been mentioned in any works on analytical chemistry, or in such journals as we have access to, has been worked out by the author and possesses sufficient merit to be put on record. It is based on the fact that in a *neutral* solution of a bismuth salt, the bismuth is precipitated as a basic acetate on boiling with sodium acetate.

The following manner of working gave the best results:—To the solution of the nitrates add sodium carbonate until a slight, but distinct, permanent, flocculent

* Contributions from the Laboratory of the University of Pennsylvania. From the *Journal of Analytical Chemistry*, Vol. i., Part 3.

No. of the series.	No. of analyses in each series.	Parts by weight taken.		Maximum per cent found.		Minimum per cent found.		Average per cent of all analyses.	
		a. Lead.	*b.* Bismuth.	*a.* Lead.	*b.* Bismuth.	*a.* Lead.	*b.* Bismuth.	*a.* Lead.	*b.* Bismuth.
1.	10	90	10	90·30	9·92	90·17	9·85	90·206	9·878
2.	7	80	20	80·32	19·87	80·25	19·80	80·289	19·846
3.	6	75	25	74·93	25·01	74·87	24·91	74·902	24·963
4.	5	50	50	50·07	49·93	49·95	49·83	49·996	49·892
5.	6	25	75	25·41	74·84	25·19	74·52	25·255	74·772
6.	5	20	80	20·31	80·01	20·07	79·83	20·172	79·910
7.	9	10	90	9·93	90·31	9·60	90·05	9·833	90·153

precipitate is formed. Then shake and stir well, which will change it to a pearly crystalline compound which settles rapidly. If now, on adding another drop of sodium carbonate solution to the clear liquid, a precipitate is formed, the solution is ready for the addition of sodium acetate, which should be done in the cold. Then the solution should be boiled vigorously for 1½ to 2 hours, filtered while hot, and washed with boiling water. Redissolve in dilute warm nitric acid and precipitate the bismuth by ammonium carbonate. The lead in the filtrate may be precipitated as chromate, or carbonate. The seven series of analyses that were made gave the above results.

NOTE ON THE

ACTION OF ELECTRIC SPARKS ON MIXTURES OF NITRIC OXIDE WITH HYDROGEN AND OTHER INFLAMMABLE GASES.

By STEPHEN COOKE, F.C.S.

Davy, in his "Researches on Nitrous Oxide," says:—"I passed a strong electric shock through equal parts of hydrogen and nitrous gas, confined by mercury in a detonating tube, but no inflammation and no perceptible diminution was produced." This statement, which I believe is quite correct, is still found in some of our works on Chemistry (*e.g.*, Gmelin's). And nothing is said about the action of sparks on these gases mixed in other proportions, although Davy, a little further on, says:—"Perhaps, if I had tried many other different proportions of the gases, I should at last had discovered one in which they would have inflamed; for, as will be seen hereafter, nitrous oxide cannot be decomposed by the compound combustible gases, except definite quantities are employed." This paragraph to a great extent anticipates my experiments on this subject.

Henry, however, is less cautious, and in his "Elements of Chemistry" (9th Ed.), he makes the following statements (on what authority I do not know, but he seems to have experimented on the subject himself):—"It [nitric oxide] does not, however, explode with hydrogen *in any proportion, nor with any of the varieties of carburetted hydrogen.*" (The italics are mine). And, again, "Nitrous gas does not, with hydrogen gas, afford a mixture that can be exploded by the electric spark." Henry's statements, as I shall show immediately, now need modification.

My own experience on this subject may not prove uninteresting. The first mixture used was equal volumes of nitric oxide and hydrogen, this being the most likely proportion to give any result. On passing sparks it was found that there was a pretty rapid contraction of the volume of gas, but no explosion. The gas left after all action was over was one-fourth the original volume. Evidently the change consisted in the reduction of nitric oxide by hydrogen—

$$NO + H_2 = N + H_2O.$$

I then took two volumes of nitric oxide and one volume of hydrogen, and on passing a spark through this mixture a pretty sharp explosion took place; white heavy fumes appeared in the tube, together with red fumes of nitric peroxide; the volume of the original gas diminished about 40 per cent, and the water in the eudiometer became strongly acid. This experiment was made over water. I then added to the residue a volume of hydrogen equal to that originally employed, and on passing a spark there was a prompt explosion. In this case no fumes (white or red) were formed.

Being busy at the time, I only made a few rough experiments, and at that time I thought the change in the first explosion consisted, for the most part, in reducing the nitric oxide to nitrous oxide, and this appeared somewhat probable, as the first explosion took place with some difficulty, sometimes requiring several sparks, while in the second stage the inflammation of the gases was easier, and the explosion appeared to have more force.

Returning to the subject some months afterwards, I was unable to get any result at all with similar mixtures of the gases. This appeared somewhat extraordinary, as I used pure nitric oxide in each case (prepared from $FeSO_4$, KNO_3, and H_2SO_4, so as to avoid any trace of nitrous oxide), and everything the same, with the exception of a eudiometer. This new eudiometer had the wires approaching each other within ⅛ of an inch, while the one formerly used was an older pattern (which had been broken in the interval), in which the wires were fully ¼ of an inch apart. Being unable to purchase one of the older kind, I made one with the wires about ¼ inch apart, and then the results were similar to those formerly obtained. Another experince may be mentioned here. During my experiments my own coil, giving an inch spark, got damaged, and being unwilling to wait for its repair, I borrowed another, giving a feebler spark. With this, however, no explosion could be got, although the spark would pass readily enough. This coil was then exchanged for one giving a 4-inch spark, and then there was no difficulty in getting an explosion every time, with the mixture already mentioned; and with the new coil a larger proportion of hydrogen could be used than with my own—a mixture of six volumes of hydrogen and ten volumes of nitric oxide exploding with this coil.

With a diminished pressure of 300 m.m. of mercury no explosion was obtained. On replacing the mercury by water the same mixture exploded readily. The carefully-dried gases exploded with equal ease to the undried gases.

Possibly with an increased pressure and greater spark, a higher proportion of hydrogen than that mentioned above might have been used.

As regards the explosion of nitric oxide and hydrogen, therefore, my experience may be summed up as follows:—

1. A spark from a feeble coil gives no explosion.
2. A spark from a larger coil gives no explosion if the wires are too close together.
3. No explosion takes place if the pressure is diminished to the extent of 300 m.m. of mercury—less than the atmospheric pressure.
4. No explosion takes place if the hydrogen has a greater proportion to the nitric oxide than 6 : 10.

In connection with 1 and 2, it may be interesting to note that Dixon, in a paper read before the Chemical

Society, about a year ago, obtained similar results with mixtures of oxygen and cyanogen gases, results which have been attributed to the greater distributing energy of the longer and more vigorous spark. The initial disturbance in these experiments not only determines the explosion, but influences to a considerable extent the resulting products.

We come now to the gases resulting from the explosions. I may state that my first experiments were made over mercury, and the gases resulting from the explosion were determined. The variation was found so great that only pretty general statements can be made. A number of my late experiments were made over water. A number of experiments were generally made with the same mixture —the gases being mixed in a small gasholder, and transferred to the eudiometer.

As illustrating the variation that may occur under like conditions, I may state that in making some experiments with a mixture of nitrous oxide and hydrogen in the proportion of 2 : 1, the residues were mixed and set aside for further examination. On adding the residues from the third explosion to the two first, red fumes were produced, showing that oxygen had been formed in the one case, and nitric oxide left undecomposed in the other.

Sometimes, owing to the greater initial disturbance of the spark, the flame passes down the tube with greater rapidity, and the explosion is more energetic than at other times. In such cases red fumes are produced, and oxygen is found in the residue.

If the eudiometer is too narrow the explosion may not travel more than a few inches from the wires, and a series of explosions may be got; but nitric oxide is left undecomposed.

Even in a wide tube the explosion may travel slowly down the tube, especially when near the bottom. In such cases nitric oxide may generally be found in the residual gases. With the apparatus mentioned, I have been able to obtain explosions when the volumes were—

$$H : NO :: 1 : 5.$$

With one volume of hydrogen to ten volumes of nitric oxide, no explosion could be obtained. The greatest amount of hydrogen with which I have been able to get an explosion is 6 vols. H to 10 vols. NO. The explosion then occurs with difficulty, and only when the larger coil I have mentioned is used. 2 vols. of H and 5 vols. of NO explode very readily. The greater number of experiments were made with mixtures of H : NO :: 2 : 5, and—

$$H : NO :: 1 : 5.$$

The gases produced by the explosion vary so considerably that a detailed account would be of little value. More than fifty experiments have been made, and in all but four or five free oxygen has been found in the residue; and this occurs with the smallest volume of hydrogen, as well as the greatest, depending more, I believe, on the force of the explosion and the temperature produced than the proportion of gases present. (For instance, thirteen experiments were made with the lowest amount of hydrogen, and in eleven of them oxygen was left). After explosion the residue left was, on the average, about 60 per cent, the extremes being 44 per cent and 71 per cent; and here, again, the proportion of gas left often depends more on the nature of the explosion than on the gases present. With two volumes of nitric oxide and one volume of hydrogen, the change may often be approximately represented by the following equation :—

$$2NO + H_2 = H_2O + N_2 + O.$$

The free oxygen is, however, always somewhat less than one-half the amount in the NO; in three cases the volume was determined and the lowest was 40·2 per cent, and the highest a little short of 45 per cent of the whole —a portion of the NO breaking up as follows :—

$$4NO = 2NO_3 + N.$$

To me the most unlooked-for reaction in these experiments is the production of free oxygen, especially when such a small volume of hydrogen is used.

I have already quoted Henry with reference to the action of hydrocarbons and nitrous oxide. Some hydrocarbons will, however, combine readily enough with NO if submitted to a suitable spark discharge, provided the volume be properly proportioned. Marsh-gas, especially, explodes more readily than hydrogen when the volume is not less than one-twentieth or greater than one-eighth of the nitric oxide used. The results show that all the carbon is oxidised to CO_2, and the residue in all my experiments contained free oxygen, this result being accounted for by the vigour of the explosion.

Sulphuretted hydrogen, when mixed with nitric oxide, can be readily exploded.

Carbonic oxide and nitric oxide did not, in any proportion, explode. There is a gradual combination, however, which may be represented by $NO + CO = CO_2 + N$.—*Glasgow Philosophical Transactions.*

OBITUARY.

PETER GRIESS.

We regret having to announce that Mr. Peter Griess, well-known as a successful discoverer of coal-tar colours, died suddenly and unexpectedly on August 30th, whilst staying at Bournemouth. We hope to furnish further particulars in a subsequent issue.

CORRESPONDENCE.

ESTIMATION OF COPPER.

To the Editor of the Chemical News.

Sir,—In the ordinary burette assay of copper by cyanide of potassium the writer has long thought that the uncertainty of the method arose in great part from the use of ammonia. This induced him to try precipitating the copper by a solution of carbonate of soda, using a solution not too strong, but in such excess as to re-dissolve the precipitate in part, as seen by the blue colour of the solution. The cyanide solution is now added, until first the precipitate dissolves, and then until the blue colour of the copper solution is discharged.

I have obtained very close results from use of the above method, and shall be glad if they are confirmed by the experiments of others.

Mr. F. L. Merry has modified the original idea by adding sufficient tartaric acid to re-dissolve the precipitate caused by the carbonate of soda to a clear blue solution, and then buretting. He has had close results by this method.—I am, &c.,

J. L. Davies.

Hafod Isha Works, Swansea,
August 23, 1888.

DR. PETERS'S AMERICAN METHODS OF COPPER SMELTING.

To the Editor of the Chemical News.

Sir,—I regret that I did not see the Chemical News of the 31st ultimo in time to reply to the letter of W. M. (Chemical News, vol. lviii., p. 108).

W. M. has made a serious mistake in stating that I took the concordant results of the electrolytic and iodide processes as evidence of proof of the accuracy of the latter, and a careful perusal of my article should have prevented him falling into such an error. As a matter of

fact the accuracy of the iodide process was proved by a series of experiments on known amounts of copper to which various impurities were added, and these experiments are given in detail in my paper (*Journal of the Society of Chemical Industry*, 1886, vol. v., pp. 52, 53), while on p. 54 I give my views and those of other analysts regarding the electrolytical method. Briefly, statements are made to the effect that bismuth, silver, and tin have been deposited with the copper, that ferric salts delay the precipitation, and, finally, the second of the propositions at the conclusion of my article runs as follows:—"That for the wet assay of copper, in ores and products generally, the iodide process (E. O. Brown's modification) is the most reliable and accurate, but that the electro-deposition method may also be used where it is desirable to have the results of two *separate* and *distinct* processes, it being noted that in certain cases other metals are deposited with the copper."

At the discussion on my paper the same doubts regarding the reliability of the electrolytical assay were expressed by other chemists, and in an article published in the *Mining Journal* (February 19th, 1887) I again refer to the subject in the following terms:—"My doubts regarding the reliability of the electrolytical process have been confirmed. Copper may in some cases be accurately determined from solutions of copper ores and products in acids, but the result is as a rule doubtful, and I find that most operators who use this method separate the copper as completely as possible from other metals, then depositing it from the purified solution by the electric current. The process so modified possesses no advantage over the iodide method, and any bismuth which may be present deposits with the copper and affects the accuracy of the results. These objections to the electrolytical method are confirmed by a footnote on p. 83 of Lunge and Hurter's "Alkali-Makers' Pocket-Book," where it is stated that the electrolytical method has not been adopted at the Duisberg Copper-Works, because copper precipitated the first time is not pure, and that two precipitations cause more trouble than the subsulphide method, which it is admitted requires an arbitrary correction for the bismuth and antimony present in pyrites."

I therefore submit that my statements regarding the relative value of the electrolytical and iodide processes have been consistent throughout, while, with regard to W. M.'s reference to the shrewdness and ability of American analysts, constituting a strong argument in favour of the electrolytic process, I am content to refer him to the extracts I have given from Dr. Peters's work, and to ask if the results there given would be considered satisfactory by any English analyst?—I am, &c.,

JAMES W. WESTMORELAND.

Leeds, September 8, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 8, August 20, 1888.

The Vapour Tension of Alcoholic Solutions.—F. M. Raoult.—The author concludes that for metallic salts as well as for organic bodies the relative decrease of the vapour tension produced by 1 mol. of the substance in 100 mols. of alcohol is approximately constant and is very close upon 0·0104.

Action of Micro-Organisms on Colouring-Matters.—J. Raulin.—The microbia of fermentation act by hydrogenation not merely upon extract of indigo. Logwood, orchil, and safranine are decolourised rapidly, and resume their colour on exposure to the air. Certain azo-derivatives, such as the ponceau 3 R of Meister and Lucius, the orangé 2 of Poirrier, and Bordeaux red, are also rapidly decolourised, but do not resume their colour on aëration. Nicholson blue and imperial violet are decolourised in a few days, whilst magenta, cochineal, and the natural colouring-matter of wine resist for weeks.

Moniteur Scientifique, Quesneville. Series 4, Vol. ii., July, 1888.

Natural and Artificial Manures.—W. L. Macadam.—From the *Journal of the Society of Chemical Industry.*

On Ultramarine.—Herbert Rawlins.—From the same *Journal.*

The Manufacture of Chlorine with Reference to the Use of Magnesia in this Process and to its Economy.—Mr. Kingzett.—From the same source.

The Composition of Water.—Prof. T. E. Thorpe.—From *Nature.*

The Relative Densities of Hydrogen and Oxygen.—Lord Rayleigh.—From the *Proceedings of the Royal Society.*

The General Reactions in the Preparation of Soda, Especially as to the Quantities of Heat Consumed.—G. Lunge.—The author finds that the Leblanc process to effect the separation of hydrochloric acid and sodium hydroxide in an aqueous solution employs fifteen times the quantity of the heat which is theoretically necessary for resolving sodium chloride into sodium and chlorine. Apparently the ammonia process is more economical in this respect, but it is only in appearance, since it furnishes neither free chlorine nor hydrochloric acid, and if we add to the process the manufacture of these latter products, the total consumption of fuel will certainly not be less than that of the Leblanc process. The energy required to effect the separation of sodium chloride into its elements is only a fraction of that which is consumed in the form of heat in the two processes at present in use. Hence it might be believed that the electrolytic decomposition might be effected by burning a much smaller quantity of coal sufficient to produce the needful sum of chemical energy in the form of electricity. Unfortunately this is not the case in practice. The useful work obtained by the intervention of electricity costs at present much more than the indirect means of decomposition now in use. This is owing to the losses of energy in the boilers, the steam-engine, the dynamo, to polarisation, and other causes not yet understood. The manufacture of soda by electricity, by the conversion of the current into chemical energy, is one of those problems which the future will certainly solve. Neither the Leblanc nor the Solvay process is industrially perfect. As regards the complete utilisation of the materials employed, the Solvay process is certainly more rational than that of Leblanc.

Natural Occurrence of Copper Antimonide.—Laist and Norton.—From the CHEMICAL NEWS.

Contribution to the Study of Grain and of Bread.—Dr. Michael Popow.—The possibility of nourishment entirely by bread may be realised if the equilibrium of nitrogen is preserved. The rye-bread of Russia, though fairly rich in nitrogenous matters, contains much cellulose and acid. The rye-bread of the country contains more cellulose than that of the towns, and is less nutritious.

On Chromium Mordants.—L. Whiteley.—The author's results have previously been published in England.

Characteristic Reactions of Artificial Colouring-matters.—Weingaertner and Zetter.—This useful memoir does not admit of abstraction.

New Antiseptics: Creoline.—V. Gerlach and R. Frühling.—Gerlach maintains that the germicide proper-

ties of creoline are incomparably more marked than those of phenol. Frühling declines to give an opinion on its antiseptic efficacy.

New Process for the Determination of Alcohol.—B. Roese.—This paper will be inserted in full.

Determination of Nitric Acid in Wine.—E. Pollak (*Chemiker Zeitung*).—One centigrm. diphenylamine is dissolved in 10 c.c. of dilute sulphuric acid (1 part pure monohydrated acid and 3 parts water). It is diluted to 50 c.c. with strong sulphuric acid. For each assay 2 c.c. are poured into a small porcelain capsule. Meantime, the wine has been concentrated and decolourised by evaporation down to one-fifth over bone-black, previously washed and ignited. It is filtered through plugs of asbestos, as filter-paper almost always contains traces of nitric acid. The author takes two capsules of porcelain, each containing the reagent, and pours into each three to six drops of the wine prepared as above. If no blue colouration appears in ten minutes the absence of nitric acid is proved. Two out of twenty-five samples of pure wine gave a very feeble blue tint at the end of ten minutes. It thus appears that perfectly pure wines may contain traces of nitric acid, but in wines diluted with water the colour is much more intense and rapid.

MISCELLANEOUS.

British Association for the Advancement of Science.—The following are the names of the Officers and Committee of Section B (Chemical Science) of the Bath Meeting of the British Association:—

President.—Prof. W. A. Tilden, D.Sc., F.R.S., V.P.C.S.

Vice-Presidents.—Prof. H. E. Armstrong, Ph.D., F.R.S.; J. H. Gladstone, Ph.D., F.R.S.; Prof. T. Sterry Hunt, F.R.S.; Prof. W. Odling, M.B., F.R.S.; W. H. Perkin, Ph.D., F.R.S.; Prof. J. Emerson Reynolds, M.A., F.R.S., M.R.I.A.; Sir H. E. Roscoe, B.A., LL.D., F.R.S.; W. J. Russell, Ph.D., F.R.S.; Prof. A. W. Williamson, LL.D., F.R.S.

Secretaries.—Prof. H. B. Dixon, M.A., F.R.S.; H. Forster Morley, M.A., D.Sc. (Recorder); R. E. Moyle, B.A.; Dr. W. W. J. Nicol, M.A., F.R.S.E.

Committee.—Sir F. A. Abel, F.R.S.; Prof. Roberts-Austen, F.R.S.; Dr. G. H. Bailey; Prof. P. P. Bedson; C. H. Bothamley; Sir I. Lowthian Bell, F.R.S.; P. Braham; Vaughan Cornish; Prof. Dunstan; T. Fairley; A. E. Fletcher; A. G. Vernon Harcourt, F.R.S.; Prof. E. Kinch; Prof. H. M'Leod, F.R.S.; Prof. R. Meldola, F.R.S.; M. M. Pattison Muir; Prof. Pickering; Dr. A. Richardson; Prof. Ramsay, F.R.S.; Dr. A. Scott; Prof. A. Smithells; Prof. H. L. Snape; H. W. Smith; John Spiller; Prof. C. M. Thomson; W. Thomson; Thomas Turner; V. H. Veley; G. Ward; R. Warington, F.R.S.

Delegate Member.—J. Brown.

The Papers brought before the Section were as follows:—

President's Address.

Report of the Committee on the Action of Light on the Hydracids in the presence of Oxygen.

Report of the Committee on the Bibliography of Solution.

Report of the Committee on the Properties of Solutions.

Report of the Committee on the Influence of Silicon on the Properties of Steel.

Report of the Committee on a Uniform System of Recording the Results of Water Analysis.

Prof. Sterry Hunt, F.R.S.—On the Study of Mineralogy.

Dr. G. Johnstone Stoney, F.R.S.—On the Logarithmic Law and its connection with the Atomic Weights.

Rev. A. Irving.—Notes on Dissociation.

J. E. Marsh.—On Camphoric Acid.

J. E. Marsh.—On Van't Hoff's Hypothesis and the Constitution of Benzene.

Discussion on the Chemical Problems presented by Living Bodies, opened by *Prof. Michael Foster, F.R.S.*

Dr. Alex. Scott.—The Atomic Weight of Oxygen.

Prof. H. B. Dixon and H. W. Smith.—The incompleteness of Combustion in Explosions.

Dr. W. W. J. Nicol.—A new Gas Analysis Apparatus.

Dr. W. Bott.—The Determination of Vapour Densities at High Temperatures and under Reduced Pressure.

Prof. P. P. Bedson.—Exhibition of a Photograph of a Hydrogen and Chlorine Bulb, produced by the Flash of Light which caused its Explosion.

J. Joly, M.A.—On the Formation of Crystals of Calcium Oxide and Magnesium Oxide in the Oxyhydrogen Flame.

The Report of the Committee on the Teaching of Chemistry.

Rev. A. Irving.—Chemistry as a School Subject.

Discussion on Valency, opened by *Prof. H. E. Armstrong, F.R.S.*

Prof. R. Meldola, F.R.S.—Evidence of the Quantivalence of Oxygen derived from the study of the Azonaphthol Compounds.

Prof. Sterry Hunt, F.R.S.—Theory of Solution.

A. P. Laurie.—The Composition of Copper-Tin Alloys.

John Spiller.—Analysis of Ancient Mortar from the Roman Wall of London.

V. H. Veley.—Action of Acids on Copper.

Fred. Bale.—Recovery of Ammonia and Chlorine in the Ammonia-Soda Process.

Report of the Committee on Isomeric Naphthalene Derivatives.

Dr. J. H. Gladstone and W. J. Hibbert.—Note on Molecular Weight of Caoutchouc and other Colloids.

Prof. J. Emerson Reynolds.—Some New Silicon Compounds.

Prof. J. Emerson Reynolds.—Some New Thiocarbamide Compounds.

Prof. J. W. Langley.—Proposed International Standards of Iron and Steel.

Dr. A. Richardson.—Action of Light on Water Colours.

Dr. William Bott and J. B. Miller.—On Pyrocresols.

Profs. Ramsay and Young.—On the Expansion, Vapour Pressures, and Vapour Densities of Water within a Large Range of Temperature.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of uae to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Solubility of Fatty Acids.—Can any of your readers tell me if the fatty acids of palmitin, stearin, and olein are slightly soluble in hot dilute sulphuric acid of the strength of 1 of acid in 20 of water; if so, to what extent?—D. W. Murch.

PATENTS, DESIGNS, & TRADE MARKS ACT, 1883.

In the Matter of Letters Patent granted to Charles Wigg, of Walmer Buildings, Water Street, Liverpool, in the County of Lancaster, for "Improvements in the manufacture of bicarbonate of soda and in apparatus therefor," dated 29th June, 1887, No. 9227.

NOTICE IS HEREBY GIVEN that the said C. Wigg has applied for leave to amend the Specification numbered as above.

A copy of the Specification as proposed to be amended can be inspected at the Patent Office; and particulars of the proposed amendment were set forth in the Official Journal of the Patent Office issued on the 8th of September, 1888.

Any person intending to oppose the said application must leave notice of objection thereto (on Form G) at the Patent Office, 25, Southampton Buildings, London, W.C., within one Calendar month from the date hereof.

Dated this 8th day of September, 1888.

(Signed)

H. READER LACK, Comptroller-General.

NOTICE.

The STUDENTS' NUMBER of the Chemical News *will be published on Friday, September 21st. Gentlemen holding official positions in the Universities, Medical Schools, &c., of the United Kingdom, where Chemistry and Physical Science form a part of the education, who have not yet forwarded the necessary information to our Office for publication in that Number, will confer a favour by sending it with the least possible delay.*

Advertisements for this Number should reach the Office not later than Wednesday, the 19th prox.

OWENS COLLEGE, Victoria University,
MANCHESTER.

CHEMISTRY COURSE.—Full particulars of this Course, qualifying for the Victoria University DEGREES in CHEMISTRY and the COLLEGE TECHNOLOGICAL CHEMISTRY Certificate, will be forwarded on application.

The Session commences October 2nd.

H. W. HOLDER, M.A., Registrar.

The London Hospital and Medical College,
MILE END, E.

The SESSION 1888-89 will commence on Monday, October 1st, 1888. The new buildings which were opened by T.R.H. the Prince and Princess of Wales, on May 21st, 1887, afford more than double the accommodation which was provided formerly

Four Entrance Scholarships, value £60, £40, £30, and £20, wil be offered for competition at the end of September to new students. Fees for lectures and hospital practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other hospital appointments are free, and the holders of all the resident appointments are provided with rooms and board entirely free of expense. The resident appointments consist of five house physiciancies, five house surgeoncies, one accoucheurship, and one receiving-room officer; one senior dresser to out patients, dressers and maternity pupils also reside in the Hospital. Special classes for the preliminary scientific and Intermediate M.B. Examinations of the University of London and for the Primary and Pass Examinations for the Fellowship of the Royal College of Surgeons of England are held throughout the year. Special entries may be made for medical and surgical practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis, and the Metropolitan, Metropolitan District, East London, and South Eastern Railways have stations within a minute's walk of the Hospital and College.

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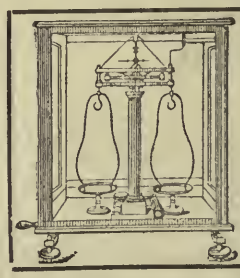

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August 27th, 1888.

THE CHEMICAL NEWS.

Vol. LVIII. No. 1504.

ADDRESS TO STUDENTS.

We have repeatedly in our "Students' Number" attempted to give some hints to those who are desirious of acquiring a knowledge of chemistry. To what extent our advice has been taken we know not. We have always insisted upon the importance of thoroughness and accuracy, and have advised all who have the necessary opportunities not to rest content with a mere verbal knowledge of the subject, but to qualify themselves as far as possible for original investigation. Perhaps such advice was unpalatable: perhaps it was rejected of compulsion as clashing with the great aim of the English student, to "pass."

Be this as it may, the conviction seems spreading that our method of teaching chemistry,—and by a parity of reasoning the other physical and natural sciences,—is scarcely what might be either desired or expected. With all the increased attention latterly paid to chemistry, with all our schools and classes and laboratories and manuals,—which are indeed legion,—and with all our everlasting examinations we make little head-way. We have not yet recovered our lost supremacy in the chemical arts, and foreigners still occupy among us not merely professorial chairs but the most important posts in our manufacturing establishments.

We have always maintained that examinationism, with its appendage "payment by results,"—so-called—is, if not *the* cause, at least one of the main causes of our unsatisfactory position. We are told, ever and anon, that examinationism is the great foe to originality.

Now it is interesting to note that in the Chemical Section of the British Association a paper has just been read on our method of teaching chemistry, the conclusion being arrived at that it is not satisfactory. We begin too often with abstractions, such as atoms and molecules, and in so doing we reverse the order of nature. Nay, even the elements are conceptions not sufficiently concrete for the earlier lessons of the pupil. Why not begin with some compound, or some naturally occurring and familar substance of a kind which may interest the learner? As an instance we find mentioned by a contemporary, certain substances in which boys take only too lively an interest; to wit, squibs, crackers, and fire-works in general. Now sulphur is certainly to the chemist very much what iron is to the engineer, the starting-point for his operations. For all that we mistrust the introduction of pyrotechny as the first step in chemistry. Boys already mutilate and damage themselves every autumn to no small extent, and sadly interfere with the peace of mind of their mature relatives. Again, danger to the youthful experimentalist being altogether ignored, we might ask whether the attention of inventors is not already turned to an unprecedented and increasing degree to the concoction of novel explosives, and whether it would be desirable to give any further impulse to this tendency? Surely some other branch of applied chemistry might be found equally instructive and more free from objections. What of colour chemistry? Numbers of boys have a propensity for dyeing, staining, and colouring, or, as their mothers and sisters call it, messing and smearing. Could not this inclination be usefully directed? All this, however, we must confess is not so much advice to students as suggestion to teachers; and the English teacher and even college professor enjoys little *Lehrfreiheit*. He cannot, like his German colleague, teach chemistry according to the dictates of his own judgment and the results of his own experience. He must conform to some "syllabus" under well-known penalties. Yet we still wonder that our chemical schools are not sufficiently fruitful in discoverers!

UNIVERSITIES AND COLLEGES.

UNIVERSITY OF LONDON.

Candidates for any Degree granted by this University are required to have passed the Matriculation Examination, and all candidates for Matriculation will henceforth be required to comply with the following instructions:—(1) Not less than five weeks before the commencement of the Examination every candidate must apply to the Registrar, by letter, for a Form of Entry, which, together with all particulars respecting the arrangements for the Examination, will be sent to him immediately on receipt of the application. (2). This form, duly filled up, must be returned to the Registrar not less than four weeks before the commencement of the Examination, and with it, in the same cover, must be sent (*a*) the candidate's certificate of age, and (*b*) his fee for the Examination. No candidate's name will be placed on the list of candidates unless his form of entry, certificate of age, and fee shall have been received at the University on or before the fourth Monday before the commencement of the Examination. As soon as possible after the closing of the list, and not previously, each candidate's certificate and fee will be acknowledged, his certificate will be returned, and a Number, by which he is to be designated throughout the Examination, will be assigned to him.

The Fee for this examination is £2.

There are two Examinations for Matriculation in each year; one commencing on the second Monday in January, and the other on the third Monday in June. The Examination is conducted by means of Printed Papers; but the Examiners are not precluded from putting, for the purpose of ascertaining the competence of the candidates to pass, *viva voce* questions to any candidate in the subjects in which they are appointed to examine.

Candidates are not approved by the Examiners unless they have shown a competent knowledge in each of the following subjects:—Latin. Any one of the following Languages:—Greek, French, German, Sanskrit, or Arabic. The English Language, English History, with the Geography relating thereto. Mathematics. Mechanics. One of the following branches of Experimental Science:—Chemistry, Heat and Light, Magnetism and Electricity.

The Examination in Chemistry is—Chemistry of the Non-metallic Elements; including their compounds—their chief physical and chemical characters—their preparation—and their characteristic tests.

A Pass Certificate, signed by the Registrar, will be delivered to each candidate who applies for it, after the Report of the Examiners has been approved by the Senate.

If in the opinion of the Examiners any candidates in the Honours Division of not more than twenty years of age at the commencement of the Examination possess sufficient merit, the first among such candidates will receive an Exhibition of thirty pounds per annum for the next two years; the second among such candidates will receive an Exhibition of twenty pounds per annum for the next two years; and the third will receive an Exhibition of fifteen pounds per annum for the next two years;

such exhibitions are payable in quarterly instalments, provided that on receiving each instalment the Exhibitioner declares his intention of presenting himself either at the two Examinations for B.A., or at the two Examinations for B.Sc., or at the Intermediate Examination in Laws, or at the Preliminary Scientific M.B. Examination, and Intermediate Examination in Medicine, within three academical years from the time of his passing the Matriculation Examination.

Under the same circumstances, the fourth among such Candidates will receive a prize to the value of ten pounds in books, philosophical instruments, or money; and the fifth and sixth will each receive a prize to the value of five pounds in books, philosophical instruments, or money.

Any candidate who may obtain a place in the Honours Division at the Matriculation Examination in January is admissible to the Intermediate Examination either in Arts or in Science in the following July.

INTERMEDIATE EXAMINATION IN SCIENCE.

The Intermediate Examination in Science will be held in July, 1889.

No candidate (with the exception of such as have obtained Honours at the Matriculation Examination in the preceding January) is admitted to this Examination within one academical year of the time of his passing the Matriculation Examination.

The Fee for this Examination is £5.

Examination for Honours.

Candidates for Honours in Chemistry will be examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition, they will be examined practically in Simple Qualitative Analysis. This Examination will consist of six hours' examination by two printed papers and of six hours' practical work.

In the Examination for Honours, the Candidate, not being more than 22 years of age at the commencement of the Pass Examination, who most distinguishes himself will receive an Exhibition of £40 per annum for the next two years.

B.Sc. EXAMINATION.

The B.Sc. Examination will be held in October.

Candidates for this Examination are required to have passed the Intermediate Examination in Science at least one academical year previously.

The Fee for this Examination is £5.

Examination for Honours.

The examination for Honours in Chemistry will take place on Monday and Tuesday in the week following the Examination for Honours in Mathematics; on Monday by printed papers (chiefly on Organic Chemistry), and on Tuesday by practical examination in Qualitative and Quantitative Analysis.

The candidate, being not more than 23 years of age, who most distinguishes himself in Chemistry, will receive £50 per annum for the next two years, with the style of University Scholar.

DOCTOR OF SCIENCE.

The examination for the Degree of Doctor of Science takes place annually within the first twenty-one days of June.

No candidate is admitted to the examination for the Degree of D.Sc. until after the expiration of two Academical Years from the time of his obtaining the Degree of B.Sc. in this University.

The Fee for this Examination is £10.

PRELIMINARY SCIENTIFIC (M.B.) EXAMINATION.*

This Examination takes place twice in each year,—once, for Pass and Honours, commencing on the third Monday in July; and once for Pass Candidates only, commencing on the third Monday in January.

No candidate shall be admitted to this Examination unless he shall have passed the Matriculation Examination, nor unless he have given notice of his intention to the Registrar at least one calendar month before the commencement of the examination.

The Fee for this examination is Five Pounds.

EXAMINATION IN SUBJECTS RELATING TO PUBLIC HEALTH.

A Special Examination will be held in December in subjects relating to public health.

No candidate is admitted to this Examination unless he has passed the Second Examination for the Degree of Bachelor of Medicine in this University at least one year previously; nor unless he shall have given notice of his intention to the Registrar at least two calendar months before the commencement of the Examination.

The Fee for this Examination is £5.

UNIVERSITY OF OXFORD.

Waynflete Professor of Chemistry.—W. Odling, M.A., F.R.S.

Every Student must reside in one or other of the Colleges or Halls, or in licensed lodgings, for a period of three years, passing at least two examinations in Arts, and one in either Mathematics, Natural Science, Law, Modern History, or Theology, when, if he obtain a first, second, or third class, he can take his B.A. Degree; if he do not gain such honour he has to pass a third examination in *Literis Humanioribus.*

The fee for students working in the Laboratory for three days in the week during the Term is £3; for students working every day, £5.

Scholarships of about the value of £75 are obtainable at Christ Church, Magdalen, and other colleges, by competitive examination in Natural Science.

More detailed information may be obtained from the University Calendar; from the professors; and from the Sub-Librarian in the Radcliffe Library or the Museum.

UNIVERSITY OF CAMBRIDGE.

Professor of Chemistry.—G. D. Liveing, M.A., F.R.S.

Jacksonian Professor of Natural and Experimental Philosophy.—J. Dewar, M.A., F.R.S.

The Student must enter at one of the Colleges, or as a Non-collegiate Student, and keep terms for three years by residence in the University. He must pass the previous examination in Classics and Mathematics, which may be done in the first or second term of residence, or, through the Oxford and Cambridge Schools Examination Board, or through the Senior Local Examinations, before commencing residence. He may then proceed to take a Degree in Arts, either continuing mathematical and classical study, and passing the ordinary examinations for B.A., or going out in one of the Honour Triposes.

The scholarships, ranging in value from £20 to £80 a year, are chiefly given for mathematical and classical proficiency. Scholarships are given for Natural Science in Trinity, St. John's, St. Peter's, Clare, Christ's, Sidney, Pembroke, Caius, and Downing Colleges; the examinations being at Easter, and in June and October.

The Chemical Laboratory of the University is open daily for the use of the Students. The Demonstrators attend daily to give instructions.

Non-collegiate Students are allowed to attend certain of the College Lectures and all the Professors' Lectures, and have the same University status and privileges as the other Students. Full particulars may be obtained by forwarding a stamped directed envelope to the Assistant Registrar, Cambridge, or from the *Cambridge University Calendar.*

UNIVERSITY OF DUBLIN.

TRINITY COLLEGE.

Professor of Chemistry.—J. Emerson Reynolds, M.D. F.R.S.

* Candidates who pass in all the subjects of the Preliminary Scientific (M.B.) Examination, and also pass *at the same time* in the Pure and Mixed Mathematics of the Intermediate Examination in Science, or who have previously passed the Intermediate Examination in Arts, are admissible to the B.Sc. Examination.

Assistant Lecturer.—Augustus E. Dixon, M.D., F.C.S.
Demonstrators.— William Early, F.I.C., and Emil A. Werner.

The general Laboratories now include working accommodation for 120 Students, and the Quantitative and Research Laboratories for about 40 Students. The new Lecture Hall provides full accommodation for 340 Students. Lectures will commence about November 1st.

The Laboratories and the Lectures of the Professor of Chemistry can now be attended by Students who do not desire to reside in the University or proceed to its Degrees.

The full Course of General and Analytical Chemistry occupies three years, but a Student is free in his third year to devote most of his time to a special department of Pure or Technical Chemistry. Students can enter for any portion of the Course. The following Lectures are delivered:—

1. *Inorganic Chemistry and Chemical Philosophy.*—Elementary, first year; advanced, second year.
2. *Organic Chemistry.*—General, second year; advanced, third year.
3. *Metallurgy.*—A Course for Engineering and Technical Students.

The Laboratories are open every day from 10 to 5 o'clock (except Saturdays, when they close at 1 o'clock).

The Summer Course of Practical Chemistry for Medical Students begins during the first week in April and terminates with the first week in July.

KING'S COLLEGE.

(Department of Engineering and Applied Science.)

Professor of Chemistry.—J. M. Thomson, F.C.S.
Demonstrator of Practical Chemistry.—G. S. Johnson, F.C.S.
Assistant Demonstrator.—Herbert Jackson, F.C.S.

On Tuesday and Thursday at 10.20 a.m. Students of the First Year are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a View of the Forces which concur to the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic elements and their principal Compounds are described.

The Metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts; and the processes of the different Manufactures and of Domestic Economy are explained and illustrated.

Examinations of the Class, both *vivâ voce* and by written papers, are held at intervals during the course at the usual Lecture hour.

Second Year.—Students attend in the Laboratory twice a week, on Tuesday and Friday, at 10.20, and they go through a course of Manipulation in the most important operations of Chemistry, including the first steps of Analysis.

Any Student of this Department may be admitted to this Class at any period of his study on payment of an extra fee.

Experimental and Analytical Chemistry in the Laboratory.—The object of this Class is to afford to Students who are desirous of acquiring a knowledge of analysis, or of prosecuting original research, an opportunity of doing so under the superintendence of the Professor and Demonstrator; Students may enter, upon payment of extra Fees, at any time except during the vacation, and for a period of one, three, six, or nine months, as may best suit their convenience. The laboratory hours are from ten till four daily, except Saturday, on which day the hours are from ten till one.

In addition to the Laboratory Fee, each Student defrays the expenses of his own Experiments. The amount of this expense, which is comparatively trifling, is entirely under his own control.

Special hours and fees are arranged for the convenience of such Third Year Students as wish to study Analytical Chemistry.

Fees.—Chemistry per term, £3 8s. 0d.; per ann., £8 8s. 0d.; Practical Chemistry per term, £4 4s. 0d.; per ann., £10 10s. 0d.; Experimental and Analytical Chemistry—One Month (daily attendance), £4 5s. 0d.; Three Months (daily attendance), £10 10s. 0d.; Six Months (daily attendance), £18 18s. 0d.; Nine Months (daily attendance), £26 5s. 0d. A student taking a month's ticket may attend daily during 1 month, or 3 days a week during 2 months, or 2 days a week during 3 months.

Rules as to Admission of Students.

I. The Academical Year consists of Three terms: Michaelmas Term, from beginning of October to the week before Christmas; Lent Term, from the middle of January to the week before Easter; Easter Term, from Easter to the beginning of July.

II. The days fixed for the Admission of New Students in the Academical Year 1888-89, are Tuesday, October 2, Wednesday, January 16, and Wednesday, May 1.

Metallurgy.

Professor.—A. K. Huntington, F.I.C., F.C.S., &c.

The following subjects are treated of in the Lectures: The Selection and Economic Preparation of Fuel and of Refractory Materials; the methods by which metals are obtained from their ores, and the means by which they are rendered suitable for the various requirements of the Arts.

Particular attention is made to the study of the Nature and Properties of Metals and Alloys available for Constructive Purposes.

In the Metallurgical Laboratory, which is always open during College hours, the relation between the Chemical Composition of Metals and their Mechanical Properties may be studied by the aid of Testing Machinery. The instruction given to each student is regulated by his special requirements.

Photography.

Lecturer.—J. M. Thomson, F.R.S.E., F.C.S.

Arrangements are made for a complete Course of Instruction in Photography to the students of the third year. A glass house has been erected, and in connection with it a Laboratory for the preparation of Photographic Chemicals. Students entering to this department will be afforded every facility for practising the Art in all its branches.

In addition to the regular College Course in Photography occasional classes are formed, consisting each of about six gentlemen, who meet twice a week. The fee for private instruction is £5 5s. for ten lessons, or £10 10s. for three courses. There is in every case a charge of £1 each course for chemicals.

Evening Classes.

Classes for Evening Instruction in various subjects are held during the months from October to March, inclusive, and during the months of April, May, and June.

UNIVERSITY COLLEGE.

Faculty of Science.

Professor.—William Ramsay, Ph.D.
Assistant Professor.—R. T. Plimpton, Ph.D.
Assistants.—S. Rideal, D.Sc., F.C.S., N. Collie, Ph.D.

The Session is divided into three Terms, as follows, all the dates being inclusive:—

First Term, from Thursday, October 4th, until Friday, December 21st;

Second Term, from Tuesday, January 8th, 1889, till Saturday, March 23rd;

Third Term, for Lectures, from Monday, March 25th, till Tuesday, June 18th. Class Examinations occupy about ten days, beginning on Wednesday, June 19th.

Students, who having entered in October do not intend to present themselves in all three subjects at the July Preliminary Science Examination, should during the first term confine their attention to Chemistry, and take this subject alone at the January Examination.

Students entering in January should take Physics and Biology at the July Examination, and Chemistry at the succeeding January Examination.

Junior or Matriculation Course.

Tuesday, Thursday, and Saturday, at 10, commencing October 4, 1888, and April 2nd, 1889. Fee:—£4 4s.

These Courses will each consist of about thirty lessons, partly theoretical and partly practical, on the non-metallic elements. Frequent exercises will be given.

Senior Course of Chemistry.

First and Second Terms: Inorganic.—The Class meets four times a week: Mondays, Wednesdays, Fridays, and Saturdays, at 9, for Lectures, Examinations, and Exercises.

Fee:—For the Course, £7 7s.; Perpetual, £9 9s.; for the First or Second Terms, £4 4s.

This Course and the Practical Class cover the subject as prescribed for the Preliminary Scientific (M.B.) and Intermediate Examination in Science of the University of London.

For the Preliminary Scientific Examination Students who take the three subjects for that examination in July attend during the First and Second Terms.

Advanced Course of Chemistry.

Second and Third Terms.—The class meets twice a week, on Tuesdays and Thursdays, at 9. The hour will be altered by special arrangement with the class if necessary.

Fee:—For the Course, £5 5s.; for the Second or Third Terms, £3 3s.

This Course will be found suitable for those about to proceed to graduation as Bachelor of Science in London University, and to those who intend to choose Chemistry as a profession. Such students should also work in the Laboratory during as many hours as they can spare.

Organic Chemistry.

Tuesday, Thursday, and Saturday, at 10, in the Second Term; and Monday, Wednesday, and Friday, at 9, in the Third Term. The hour of meeting will be altered should the class desire it.

This Course of Organic Chemistry is intended for those who in studying the subject have not a Medical Examination chiefly in view. Candidates for Honours at the Int.M.B. are, however, recommended to attend this Course during the Second and Third Terms, instead of the Special Summer Course.

The Course includes the subjects required at the B.Sc. Examination, Pass and Honours; but no previous acquaintance with Organic Chemistry will be expected of those joining the Class.

Fee:—For the Course, £6 6s.; for a Term, £2 12s. 6d.

An Advanced Course for those engaged in prosecuting research in Organic Chemistry will be held three times a week during the Second Term. Fee, £2 12s. 6d.

Practical Class.

First and Second Terms, on Tuesday and Thursday, at 11.

Fee, including cost of materials, £5 5s.; for a Second Course, £3 3s.

The Course includes the Practical Chemistry required at the Preliminary Scientific and Intermediate Science Examinations.

Senior Practical Class.

Saturdays from 10 to 12 during the Third Term, and two other hours to be arranged.

Fee:—(Including cost of materials) £5 5s.; for a Second Course, £3 3s.

Analytical and Practical Chemistry.

The Laboratory is open daily from 9 a.m. to 4 p.m., Saturdays excepted, from October until the middle of July, with a short recess at Christmas and at Easter.

Fees: for the Session, £26 5s.; six months, £18 18s.; three months, £10 10s.; one month, £4 4s.

Three specified days a week:—for the Session, £15 15s.; six months, £11 11s.; three months, £6 6s.; one month, £2 12s. 6d., exclusive of expense of materials. Students may enter at any period of the Session.

The Laboratory Course includes the Practical Chemistry required at the following Examinations of the University of London:—Prel. Sci. (M.B.), Intermediate M.B., Intermediate Science, B.Sc.

Students who wish to attend the Laboratory and Classes of Technical Chemistry may acquire here the requisite preliminary knowledge of Practical Chemistry and Analysis.

When accompanied by, or preceded by, attendance on the Lectures on Chemistry and Organic Chemistry, the Laboratory Course qualifies Students in the application of Chemistry to Manufactures, Metallurgy, Medicine, or Agriculture, &c.

There is also a Chemical Library containing the chief Journals and Standard Works on Chemistry.

A Gold Medal and Certificates of Honour are competed for by Students entered for the Session. The Tuffnell Scholarship (£100 for two years) will also be competed for in the Session 1888-9.

Chemical Technology.

Professor.—Charles Graham, D.Sc., F.I.C.

Assistants.—C. J. Wilson, F.C.S., and A. C. Chapman, F.C.S.

The Course of instruction in this Department is designed to afford to Students who propose to devote themselves to industrial pursuits in which Chemistry plays an important part, or to prepare themselves for the profession of Consulting Chemist, the instruction essential for their success in their future line of work. It will also be found of great value in two of the branches (Organic and Inorganic Chemistry) in which the Degree of Doctor of Science can be taken at the University of London.

In the Session 1888-89, it is proposed to treat of the following subjects:—

Heating and Lighting.
Metallurgy.
The Chemistry of the Alkali trade.
Agricultural Chemistry.

Fees—for each Course, £2 2s.; for two Courses, £3 3s. for the four Courses, £5 5s.

Courses of Lectures will also be delivered on the Chemistry of Brewing (fee, £3 3s.), and on Chemistry in its relation to Engineering and Architecture (fee £2 2s.).

Laboratory of Chemical Technology.

The instruction in the Laboratory of Chemical Technology will consist of the examination and valuation of raw materials used, and of the final products obtained in various manufacturing industries, and of experimental examination of the processes employed in the arts and manufactures.

The Laboratories are open daily from 9 a.m. to 4 p.m., from the 8th of October until the middle of July, with a short recess at Christmas and at Easter.

Fees—for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas exclusive of the expense of materials.

Residence for Students.

Students can obtain residence at University Hall, Gordon Square. Particulars can be obtained at the office of the College.

NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOL OF MINES.

Professor.—T. E. Thorpe, Ph.D., B.Sc., F.R.S.

Assistant Professor.—F. R. Japp, M.A., Ph.D., F.R.S.

Demonstrators.—P. F. Frankland, Ph.D., B.Sc., and H. Chapman Jones.

Assistants.—G. S. Newth, A. E. Tutton, and F. Guthrie.

The Normal School of Science at South Kensington is intended, primarily, for the instruction of teachers, and of students of the industrial classes selected by competition in the examinations of the Science and Art Department. The Royal School of Mines is affiliated to the Normal

School. Students entering for the Associateship of the School of Mines obtain their general scientific training in the Normal School. The instruction in the Normal School is arranged in such a manner as to give the Students a thorough training in the general principles of Science, followed by advanced instruction in one or more special branches of Science. The Associateship is granted in certain divisions or lines of study. Students who go through any one of the prescribed courses of instruction and pass the necessary Examinations receive a Certificate of Associateship of the Normal School, or of the Royal School of Mines. But students who are not candidates for the Associateship are permitted to take up the course of instruction in one or more special branches of science, and on passing the examination receive a Certificate to that effect. The Associateship of the Normal School of Science is given in one or more of the following divisions:—Mechanics, Physics, Chemistry, Biology, Geology, and Agriculture, and the Associateship of the Royal School of Mines in Metallurgy and Mining.

The course of instruction, which lasts for three years, is the same for all the divisions during the first year, after which it is specialised in accordance with the Scheme detailed in the Prospectus of the School.

The Session is divided into two Terms. The first Term begins about the 4th of October and ends about the middle of February. The second Term begins in the middle of February and ends about the middle of June.

Examinations are held at the end of each course of instruction and at such other periods as may be found necessary. On the results of these examinations the successful candidates are arranged in two classes, first and second. There are also "Honours" examinations for the subjects of the third year, the successful candidate being placed in order of merit. A student obtains the Associateship who passes in all the subjects of the first two years and of the special division he selects for his Associateship. A student who goes through the prescribed course of instruction in any subject and passes the final examination in it receives a certificate to that effect.

Students who do not wish to attend the lectures are admitted for short periods to the laboratories, at the discretion of the Professors. The fees for the laboratories are £4 per month.

Students not entering for the Associateship are admitted to any particular course of study, so far as there is room, on payment of the fees shown in the following table, which must be paid to the Registrar of the School before the commencement of each course.

	Lectures.	Laboratory.
	£	£
Chemistry	3	13
Physics	5	12
Biology with Botany	5	12
Geology with Mineralogy ..	4	8
Mechanics	4	6
Metallurgy	2	13
Mining	4	
Agriculture	4	10
Astronomical Physics	2	

Mathematics and Mechanical Drawing £3 per term. Geometrical Drawing, £3 per session. Freehand Drawing, £1 per term.

Thus the fees for the first two years amount to about £75, and for the remainder of the course for the Associateship they vary from £30 to about £40.

Both the private and the State-aided students are required to furnish themselves with certain instruments and apparatus before the commencement of the courses. These are enumerated in the syllabuses of the several subjects.

Officers of the Army, Navy, and Civil Service, recommended by their respective Departments, are admitted to the Lectures and Laboratories at half the foregoing charges.

Associates of the Normal School of Science or of the Royal School of Mines have the privilege of free admission to the Library and to all the courses of lectures.

Science teachers actually engaged in teaching who are registered by the Science and Art Department as qualified to earn payments for teaching Science may attend any course of lectures on the payment of £1.

Several valuable Exhibitions, Scholarships, and Prizes are attached to the studentship.

Summer Courses for Teachers.—Short courses of instruction are given annually, about July, in different branches of science for the benefit of teachers of science schools in the country. The courses last three weeks. About 200 teachers are admitted to them, and they receive 3rd class railway fare to and from South Kensington, and a bonus towards their incidental expenses of £3 each. (See Science Directory.)

Working Men's Lectures.—Three courses of evening lectures for working men will be given during the session in Geology, Mechanics, and Metallurgy. The admission to each course of six lectures will be 6d. The number of tickets is limited by the size of the lecture theatre.

UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH.

Professor.—H. Ll. Snape, D.Sc., F.C.S.

The College is open to male and female students not under the age of 15 years. The Session opened on Tuesday, September 8.

Lecture Courses.—Matriculation Course, during Lent and Easter Terms. Intermediate Science Pass Course, during Lent and Easter Terms. Intermediate Science Honours Course, during Lent and Easter Terms. B.Sc. Course, throughout the Session.

Laboratory Courses.—Intermediate Science Pass Course, Intermediate Science Honours Course, and B.Sc. Course.

The Fee for the whole Session, paid in advance, is £10; if paid by single Terms, for the first Term of attendance in each Session £4; for the second Term, £3 10s.; for the third Term £3. Any person wishing to attend single classes may do so on payment of the sum of £1 per Term for each class.

Practical Chemistry.—The Laboratory is open to Students daily during the Session from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except Saturdays.

Special courses will be arranged for those Students who intend following Medicine or Pharmacy, and every facility will be given to those desirous of studying more especially some one particular branch of Applied Chemistry.

Several valuable Scholarships and Exhibitions are attached to the Studentship.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE.

Professor.—C. M. Thompson, M.A., D.Sc., F.C.S.

Demonstrator.—J. Tudor Cundall.

The Session commences October 1st, and terminates in June, and is divided into three terms.

The Junior Course (delivered during the Michaelmas term only) consists of about 55 lectures, and will cover the subjects prescribed for the London University Matriculation examination. Fee, £2 2s.

The Intermediate Course consists of 90 lectures in continuation of the Junior Series, and, together with laboratory practice, will cover the subjects required for the Intermediate Examination in Science and the Prel. Sci. (M.B.) Examination of the University of London. Fee £3 3s.

The Senior Course includes some 90 lectures devoted to Organic Chemistry; Fee, £3 3s.

A course of 30 lectures on Qualitative and Quantitative Analysis and Chemical Calculations. £1 1s.

The Laboratory Course may be modified to meet the requirements of individual students wishing to obtain a special knowledge in some branch of manufacturing or industrial chemistry. Hours, 9 to 1 and 2 to 4.30; Satur-

day, 9 to 1. Fees—Six hours per week, £3 3s. per session; twelve hours, £2 2s. per term; eighteen hours, £3 3s. per term; twenty-four hours, £4 4s. per term.

Professors Thompson and Parker are recognised by the Universities of Edinburgh and Glasgow as teachers in Chemistry and Natural History respectively, so that registered Medical Students can spend one year of their course at the University College, Cardiff. The College is also recognised as an institution at which two years of the course for the degree of Bachelor of Science of the University of Edinburgh may be spent.

Evening Lectures.—A course of Lectures will be given on Elementary Chemistry. The Laboratory will be open on Monday evenings during the Michaelmas and Lent terms.

At the entrance examination in September, and the annual examination in June, several scholarships, &c., are awarded.

A Hall of Residence for Female Students is attached to the University, and new Chemical, Physical, &c., Laboratories were opened by Sir William Grove in October last.

UNIVERSITY COLLEGE, BRISTOL.

Professor of Chemistry.—Sydney Young, D.Sc.

Lecturer.—Arthur Richardson, Ph.D.

The session 1888-89 will begin on October 10. Lectures and classes are held every day and evening throughout the Session. In the Chemical Department lectures and classes are given in all branches of theoretical chemistry, and instruction in practical chemistry is given daily in the chemical laboratory. Excursions to some of the mines, manufactories, and chemical works of the neighbourhood are occasionally made. The department of experimental physics includes various courses of lectures arranged progressively, and practical instruction is given in the physical and electrical laboratory. The Department of Engineering and the Constructive Professions is designed to afford a thorough scientific education to students intending to become engineers, or to enter any of the allied professions, and to supplement the ordinary professional training by systematic technical teaching. This department includes courses specially arranged for students intending to become civil, mechanical, electrical, or mining engineers, surveyors, or architects. Those who attend the mechanical engineering course enter engineering works during the six summer months, and, in accordance with this scheme, various manufacturing engineers in the neighbourhood have consented to receive students of the College into their offices and workshops as articled pupils. Medical education is provided by the Bristol Medical School, which is affiliated to the College. Several Scholarships are tenable at the College.

Day Lectures.

Inorganic Chemistry.

The Course treats of the principles of Chemistry, and of the Chemistry of the Non-Metals and Metals.

Lectures will be given daily at 9 and 10 o'clock.

Organic Chemistry.

This Course will relate to the more important groups of the Compounds of Carbon.

Lectures will be given during the Second Term on Tuesdays and Thursdays at 10 o'clock; during the Third Term on Tuesdays, Thursdays, and Saturdays at 10 o'clock.

Fee, £3 3s.

Practical Chemistry.—Laboratory Instruction.

The Laboratory will be open daily from 10 a.m. to 5 p.m., except on Saturdays, when it will close at 1 p.m. Instruction will be given in the Laboratory in all branches of Practical Chemistry, including Qualitative and Quantitative Inorganic and Organic Analysis, the preparation of Chemical Products, and Inorganic and Organic Research. Special facilities will be afforded to those who desire to study Practical Chemistry as applied to the different processes employed in the Arts and Manufactures, and to Scouring, Bleaching, and Dyeing. The Laboratory is under the immediate supervision of the Professor and the Lecturer.

Fees in Guineas—

	6 Days a Week.	5 Days a Week.	4 Days a Week.	3 Days a Week.	2 Days a Week.
Per Session	17	15	13	10	7½
,, Two Terms ..	13	11	9	7½	5½
,, One Term ..	7	6	5	4	3
,, Month	3	3	2	2	1½

Students may arrange to divide their days of laboratory work into half-days.

Photographic Chemistry.

A Course of Lectures will be given by Mr. A. Richardson, Ph.D., on Mondays at 10, which will cover the subject as prescribed for the Technological Examination of the City and Guilds of London Institute; fee, £1 1s. for each term. The Photographic Laboratory is open from 10 to 5 every Wednesday; fee, £3 3s. for each term. A Course of Evening Lectures on the same subject will also be given on Fridays at 7.

Evening Lectures.

This course will consist of Two Lectures a week during the First and Second Terms; they will be devoted to the consideration of the general Principles of Chemistry and Chemical Physics and the Chemistry of Non-Metallic Elements. Special attention will be paid throughout to those products which have a practical application in the Arts and Manufactures.

Fee, 15s. for Two Terms; 10s. for One Term.

Special Courses of Lectures will be given during the First Term on the Chemistry of Potting, Tuesdays, at 8; and during the Second Term on Elementary Chemistry as Applied to Brewing, Mondays, at 8.

Chemical Scholarship.—Among others, a Chemical Scholarship of £25 is offered for competition.

With the approval of the Council of the Institute of Chemistry students desiring to qualify as Associates may pass through the requisite amount of study at this College, which has also been approved as a centre for the Practical Examination of the Institute.

MASON SCIENCE COLLEGE, BIRMINGHAM.

Professor.—W. A. Tilden, D.Sc. Lond., F.R.S.

Assistant Lecturer.—W. W. J. Nicol, M.A., D.Sc., Edin.

Demonstrator.—Thomas Turner, F.C.S.

The Session will be opened on Monday, October 1st, 1888.

Elementary Course.

Forty Lectures adapted to the requirements of beginners will be given in the Winter and Spring Terms. A Second Course of Twenty Lectures, having reference only to the subjects included in the syllabus of the Matriculation Examination of the University of London, will be given in the Summer Term. Lecture days—Wednesdays and Fridays at 11.30, Thursdays at 3.30.

Persons entirely unacquainted with Chemistry are recommended to attend the first of these Courses before entering for the General Course, which commences in October. Candidates for the Matriculation Examination of the University of London are advised to attend both these Courses.

General Course.

The General Course of Lectures on Chemistry will be found useful by Students who are afterwards to become Engineers, Architects, Builders, Brewers, or Manufacturers (such as Metallurgists, Alkali, Soap, Manure, Glass, or Cement Makers, Bleachers and Dyers, &c.)

Students preparing for the Intermediate Examination in Science and Preliminary Scientific (M.B.) Examination of the University of London should attend the Lectures on *Inorganic Chemistry* (Winter and Spring Terms).

Candidates for B.Sc. and Intermediate Examinations

in Medicine will in general require only that part of the course (Summer Term) which relates to *Organic Chemistry*.

The full course, extending over three terms, will also satisfy the requirements of Students preparing for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

1. From October to March (Winter and Spring Terms). About one hundred lectures on *Inorganic Chemistry and Chemical Philosophy* will be given on Mondays, Tuesdays, Wednesdays, Thursdays, and Fridays, at 9.30 a.m. Fee, £5 5s. for the course.

2. April to June (Summer Term). About forty lectures will be given on *Organic Chemistry*, or the chemistry of the most important series of carbon compounds. This course will include all the subjects required for the Intermediate Examination in Medicine of the University of London. Lecture Days—Monday, Tuesday, Wednesday, Thursday, and Friday at 9.30 a.m. Fee, £2 2s.

In all these courses the instruction will often take the form of class teaching, and exercises will be set which students will be expected to work at home.

An Advanced Course for the study of Theoretical Chemistry and those parts of the subject which are required for the degree of B.Sc. in the University of London will meet once a week. Fee for the session £3 3s.

Laboratory Practice.

The College Laboratory will be open daily from 9.30 to 5, except on Saturdays, when it will be closed at 1 p.m.

Candidates for Intermediate Examination in Science, Preliminary Scientific (M.B.), B.Sc., and Intermediate Examination in Medicine of the University of London, may obtain in the Laboratory of the College the instruction necessary. The three months Course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health, may be taken in the Mason College Laboratory.

The Ordinary Course for Medical Students is given on Mondays, Tuesdays, and Thursdays from 2.30 to 4.30 p.m. throughout the Summer Term.

Fees :—

	All day.	Three hours per day.
One Term	7 guineas	4½ guineas.
Two Terms	13 "	8½ "
Threee Terms	18 "	12 "

A Course of short demonstrations and exercises will be given by the Professor or one of his Assistants once a week. All first-year Students will be required to attend, unless exempted for special reasons by the Professor. No Fee.

Metallurgy.—Three Courses of Ten Lectures will be given on the Principles and Practice of Metallurgy. Fee, 10s. 6d. for each course.

Arrangements have been made in the Chemical Laboratory for giving instruction in Practical Metallurgy.

Evening Classes.

Several Courses of Evening Lectures are arranged during the Winter and Spring Terms of each session. The subjects are treated in a less technical manner and the fees are nominal.

Excursions.

During previous Sessions permission has been obtained to visit some of the great factories in or near Birmingham, in which chemical and metallurgical industries are carried on. Students have thus had most valuable opportunities of gaining a practical acquaintance with some branches of Applied Science. The privilege thus courteously granted by several manufacturers will, it is hoped, be enjoyed in every future Session. The excursions will be conducted by the Professor.

BRADFORD TECHNICAL COLLEGE.

Chemistry and Dyeing Department.

Professor.—Edmund Knecht, Ph.D., F.I.C.

Demonstrator.—Charles H. Jessop.

Lecturer on Technical Analysis.—C. Rawson, F.I.C. F.C.S.

Lecturer on Botany and Materia Medica.—William West, F.L.S.

The school year is divided into three terms. The Session began on September 17th and terminates on July 7th. The course of instruction extends over two years, and embraces Lecture Courses on Inorganic and Organic Chemistry, the technology of the textile fibres, mordants, natural and artificial colouring matters, technical analysis, and laboratory practice in analytical chemistry, chemical preparations, and dyeing. Inclusive fee, £4 4s. per term.

During the first and second terms Evening Classes are held for the benefit of persons engaged during the day and for pharmaceutical students.

ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.

Chemical Department.

Professor.—Prof. E. Kinch, F.C.S., F.I.C.

Assistants.—A. G. Bloxam, F.C.S., and W. James.

Systematic courses of Lectures are given on the various branches of Chemistry in its relation to Agriculture, illustrated by experiments, and by the collections in the College Museum. They comprise the laws of Chemical Combination and the general Chemistry of mineral bodies, and of the more frequently occurring bodies of organic origin, with the relationships of their leading groups; and, finally, the applications to practical operations of the Chemistry of the atmosphere, of soils and manures, of vegetation and stock feeding, and of the processes and products of the dairy.

In the Laboratory practical instruction is given in the construction and use of apparatus and in Chemical manipulation and analysis, both qualitative and quantitative. After studying the simple operations and the properties of the commonly occurring substances, the Students are taught to analyse a series of compounds, and apply the knowledge thus obtained to the analysis of manures, soils, waters, feeding stuffs, dairy products, and other substances met with in the ordinary course of Agricultural practice. Chemico-agricultural researches are undertaken by the senior Students under the direction of the Professor and his Assistants.

VICTORIA UNIVERSITY.

THE YORKSHIRE COLLEGE, LEEDS.

Professor of Chemistry.—Arthur Smithells, B.Sc. Lond., F.C.S.

Assistant Lecturers.—C. H. Bothamley, F.C.S., and Herbert Ingle.

The Session begins October 1, 1888.

Lecture Courses.

1. General Course of Chemistry.—Monday, Wednesday, and Friday, at 11.30 a.m., from October to the end of the second term. Fee for the Course, £3 13s. 6d.

2. Inorganic Chemistry.—First years' Honours Course, Non-metals, Monday, Wednesday, and Friday, at 9.30 a.m.. Fee, £3 13s. 6d.

3. Inorganic Chemistry. — Second years' Honours Course, Metals. Three hours weekly. Fee, £3 13s. 6d.

4. Organic Chemistry.—Tuesday and Thursday at 12.30 p.m. Fee £2 12s. 6d.

5. Theoretical Chemistry.— Advanced Course. Fee, £1 11s. 6d.

6. Chemistry as Applied to Coal Mining.— Tuesday during the First Term, at 4 p.m.

7. Photographic Manipulation.—A Course of Ten Lessons will be given on Fridays, from 2 to 5, during the

Third Term, with special reference to dry plate processes and silver and platinum printing. Fee, £1.

Laboratory Courses.

The College Laboratory will be open daily from 9 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it will close at 1 p.m.

Fees for the Session—Students working six days per week, £18 18s.; five, £16 16s.; four, £14 14s.; three, £12 12s.

Class in Practical Chemistry, Saturday mornings, from 9.30 to 12.30. Fee £1 11s. 6d.

Practical Chemistry for Medical Students.—On Tuesday and Thursday, from 10 to 12 a.m., from May to July.

Evening Classes.

A Course of twenty Lectures by Mr. C. H. Bothamley, on the Elements of Inorganic Chemistry (the Non-Metals) will begin during the first and second Terms, on Wednesdays, at 7.30 p.m., beginning October 10. Fee, 10s. 6d.

Dyeing Department.

Professor.—J. J. Hummel, F.C.S.

This Course extends over a period of three years, and is intended for those who wish to obtain a full scientific and practical education in the art of dyeing. It is suitable for those who purpose in the future to take any part in the direction of the operations of dyeing or printing of textile fabrics, *e.g.*, the sons of manufacturers, calico printers, managers, master dyers, &c.

Several valuable Scholarships are at the disposal of the College, viz., the Cavendish, Salt, Akroyd, Brown, Emsley, Craven, and Clothworkers' Scholarships, and the Leighton Trustees' Exhibition.

UNIVERSITY COLLEGE, LIVERPOOL.

Professor.—J. Campbell Brown, D.Sc.

Demonstrators.—C. A. Kohn, B.Sc., Ph.D., and S. G. Rawson, B.Sc.

Assistants.—H. H. Froysell and A. C. Wilson.

The Session commences October 1st.

The Classes are arranged to suit the requirements of candidates for the Ordinary B.Sc. Degree, or for Chemistry Honours in Victoria University; for Degrees in Medicine of Victoria, London, and Edinburgh; for a special Technological Certificate of University College; and for those studying Chemistry as a preparation for professional, technical, or commercial life. The Classes qualify for the Fellowship of the Institute of Chemistry of Great Britain and Ireland, and other Examination Boards.

Lecture Courses (Elementary).

General Course on the principal non-metallic elements and the most important metals, the principles of Chemical Philosophy, and an introductory sketeh of Organic Chemistry.

Course A.—Non-metals.

Course B.—Chemistry of the Metals.

Course D.—Organic Chemistry.

Course E.—I. History of Chemistry and Development of Modern Chemical Philosophy. II. Chemical Physics.

Course F.—Technological Chemistry: Lectures on Technology are given in connection with Laboratory work at hours to be arranged. The subjects are varied in different years. (1) Alkali and Allied Manufactures. (2) Copper. Iron. (3) Distillation of Coal, and Tar Industries. (4) Fuel. (5) Chemistry Applied to Sanitation. (6) Technical Gas Analysis. (7) Spectroscopy.

Practical Classes.

(1) Junior. (2) Intermediate. Saturday, 9.30 a.m. to 12.0. Qualitative Analysis of Inorganic Substances and of some of the more common Organic Substances. (3) Special: For the Conjoint Board of Colleges of Physicians and Surgeons. (4) Senior: Practical Organic (Advanced Medical Class). (5) Practical Exercises on Technology, Pharmaceutical Chemistry, Sanitary subjects, Adulterations of Drugs and of Food, Examination of Water and Air, of Animal Secretions, Urinary Deposits, Calculi, and Poisons. (6) Quantitative Class. Course arranged to suit the requirements of the London University B.Sc. Examinations, Pass and Honours, and for Intermediate M.B. Honours.

Chemical Laboratory.

The Chemical Laboratories provide accommodation for every kind of chemical work.

TABLE OF FEES.

Per Week.	One Month.	One Term, Three Months.	Two Terms, Six Months.	Three Terms, One Session.
One day ..	—	£4	£6	£8
Two days ..	—	5	8	10
Three days..	£4	7	10	12
Four days ..	5	8	12	15
Five days ..	—	9	14	18

Students desirous of gaining a thorough theoretical and practical acquaintance with Technical Chemistry, or who intend to adopt Chemical work as a profession, must devote three or four years to special study.

Technological Curriculum.

First Year.—Chemistry, either the Elementary Course or Course A, according to the previous knowledge of the Student. Practical Classes 1 and 2. Mathematics and Mechanics. Engineering Drawing and Design, or this may be taken in following year. French or German. Physics.

Second Year.—Chemistry—Courses A and B; Chemical Laboratory two or three days per week, and the Practical Organic Class during the Summer Term; Technological Chemistry, one Term, Course F.

Third Year.—Chemistry, Lecture Course on Organic Chemistry, D. Lecture Course, E, and Chemical Physics. Technological Chemistry, Course F. Chemical Laboratory, four or five days per week. Engineering—Strength of Materials. The Final Examination for the degree of B.Sc. may be taken if the Student is sufficiently diligent. By spending four years instead of three years, namely, three years after passing the Preliminary Examination, an able Student may take the B.Sc. degree in the Honours School of Chemistry. Students may finally choose a special subject either of research or of applied Chemistry.

Evening Classes.

Lectures will be given on Organic Chemistry, the Manufacture of Alkali and Kindred Industries, and on Thermo-Chemistry.

The Sheridan Muspratt Chemical Scholarship of £50 per annum, tenable for two years, will be awarded in December on an Examination in subjects which are included in the first two years of the above curriculum. Other Scholarships, Entrance Scholarships, and Free Studentships are also available to Students.

The Laboratory is opened for Students from 10 a.m. to to 5 p.m. daily, on Saturdays from 10 to 1 only.

The Prospectus containing full particulars may be obtained from Adam Holden, 48, Church St., Liverpool, price 6d.; or from the Registrar, University College, Liverpool.

LIVERPOOL COLLEGE OF CHEMISTRY.

Principal.—George Tate, Ph.D., F.G.S., F.C.S.

The Laboratories are open daily from 10 to 5, excepting Saturdays, when they close at 1 p.m. The course of instruction is adapted to the requirements of students o Chemistry as a science, and in its applications to chemical and metallurgical industries. The fee for a three years' course of study is eighty-five guineas, or per session of three months ten guineas.

Prospectuses, containing full particulars of the day and evening classes, may be had on application at the College.

DURHAM COLLEGE OF SCIENCE, NEWCASTLE-ON-TYNE.

Professor of Chemistry.—P. Phillips Bedson, D.Sc., F.C.S.

Demonstrator—Saville Shaw.

The Session will commence on October 8th, 1888.

Junior Division: First Year Course.—This Course of Lectures will extend over the three terms of the Session, and is intended to serve as an introduction to the Science. The Lectures will be of an elementary character, and whilst framed to meet the requirements of First Year Students will also be serviceable to such as intend pursuing Chemistry in its various applications in the arts and manufactures, as, for instance, Brewing, Metallurgy, the Manufacture of Soda, Soap, Glass, &c. The subjects treated will include an exposition of the Principles of Chemistry, and a description of the preparation and properties of the chief Elementary Substances, both metallic and non-metallic, and their more important native and artificial compounds. The class will meet on Mondays, Wednesdays, and Fridays, at 11 a.m., and will commence on Wednesday, October 17th.

Senior Division: Second Year Course.—A Course of about ninety Lectures will be given throughout the Session, the subject of which will be Organic Chemistry, or the Chemistry of the Carbon Compounds. This class will meet on Tuesdays and Thursdays, at 11, and Fridays, at 3 p.m., and will commence on Tuesday, October 16th.

Fee, for either Course, five guineas for the Session.

An Advanced Class will be formed for the study of Theoretical Chemistry. Fee, £2 2s.

A Lecture Course in Analytical Chemistry will be given on Mondays, at 3 p.m., commencing October 22nd. Fee, £1 1s.

Practical Chemistry.—The Laboratory is open from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it closes at 1 p.m. *Laboratory Fees.*—Students working six days per week, £5 5s. per term; alternate days, £3 3s.; one day per week, £1 1s.

Courses of Study.—Students will be divided into two classes:—(1) Regular, or Matriculated Students; and (2) Non-Matriculated Students. Regular Students will be required to follow such a course of study in the subjects professed in the College as will enable them to pass the Examinations for the title of Associate in Physical Science. Non-Matriculated Students will attend such classes as they may select. Every candidate for admission as a matriculated student must pass an examination on entrance, in reading, writing from dictation, English or Latin Grammar, arithmetic (including decimals), and geography. Registered students in medicine are exempted from this examination, or students who produce a certificate of having passed either of the two following examinations:—

1. Durham Examination for certificate of proficiency in General Education, held in March and September.

2. Durham Examination for Students in Arts in their first year, or any examination of a similar nature that may be accepted by the Council.

Associateship in Physical Science.—Every candidate for the Associateship in Physical Science will be required to satisfy the examiners in three, at least, of the four subjects,—Mathematics, Physics, Chemistry, and Geology,—in an examination, to be held at the beginning of his second year.

Exhibitions.—Three Exhibitions of the value of £25, £15, and £10 respectively will be awarded in October next to Candidates desirous of attending the first year course of study in the College.

Evening Lectures.—Courses of Evening Lectures will be given, with a Practical Class for Laboratory instruction.

The examination will be held at the College, and will commence on Monday, October 8th.

Two Exhibitions of £15 each will be awarded at the next examination of "Persons not members of the University," which will be held at Durham in March next.

Several other valuable Scholarships are available for students.

OWENS COLLEGE, VICTORIA UNIVERSITY, MANCHESTER.

Professor and Director of the Chemical Laboratory.—Harold B. Dixon, M.A., F.R.S.

Professor of Organic Chemistry.—C. Schorlemmer, F.R.S.

Lecturer on Technological Chemistry.—Watson Smith, F.C.S., F.I.C.

Demonstrators and Assistant Lecturers.—Julius B. Cohen, Ph.D., and George H. Bailey, D.Sc.

The Session begins on October 2, 1888, and ends on June 22, 1889.

The instruction is given by means of Experimental Lectures and Tutorial Classes. The Chemical Classes form part of the Courses for Chemistry in the University.

General Chemistry.

General Chemistry Course.—Tuesdays, Thursdays, and Saturdays, at 9.30, during the two Winter Terms.

Introduction to Organic Chemistry.—Mondays and Fridays, at 10.30, during Lent Term.

These courses are intended for Medical Students and others beginning the study of chemistry.

First Year Honour Course.—Mondays, Wednesdays, and Fridays, 3.30 p.m., during the two Winter Terms. The Non-Metals.

Second Year Honour Course.—Mondays, Wednesdays, Fridays, 9.30, during the two Winter Terms. The Metals.

Third Year Honour Course.—Tuesdays, 11.30. Chemical Physics.

Organic Chemistry (Honours).—Tuesdays, Thursdays, Saturdays, 9.30, during the Session.

History of Chemistry and Chemical Philosophy.—Thursdays, 10.30, during the Session.

Technological Chemistry.

Persons desiring to attend this course will be required to enter the College under the ordinary conditions of studentship.

The object of this course is to offer to students intending to devote themselves more especially to Applied Chemistry as complete a training as the College can provide in those branches of instruction which form the scientific foundation of the subject.

The complete course of instruction extends over four years, and embraces the following subjects:—

First Year.—Chemistry Lectures, General Course. Preparatory:—Chemical Laboratory, two days per week. Pure Mathematics. Elementary Mechanics. Geology. French or German. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Second Year.—Chemistry Lectures, First year Honour classes. Chemical Laboratory, three days per week. Technological Chemistry Lectures. Elementary Physics or Mineralogy Lectures and Practical Courses. German or French. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Third Year.—Chemistry Lectures, Second year Honour. Organic Chemistry Lectures. Chemical Philosophy. Chemical Laboratory, three days per week. Technological Chemistry Lectures (second course). Physical Laboratory, 1 day per week, or Advanced Mineralogy Lectures and Practical Course. Mechanical Drawing, Practical (evening class).

Fourth Year.—Organic Chemistry Lectures. Technological Chemistry Lectures (third year's course). Chemical Laboratory, 4 days per week. Mechanical Drawing, Practical (evening class).

Fees.—Every student is required to pay on admission an entrance fee of £1 1s. and a library fee of 5s., and the fees for the classes for which he enters. As alternative courses are in some instances open to a student offering himself for the Victoria University Examinations, it is not practicable to give tabular statements of the fees

for every combination of classes. Special prospectuses may be obtained at the office of the College.

Certificates will be granted to students on the successful completion of this course. Attendance on the full course of four years is expected of candidates for the Certificate, but students may obtain exemption (on cause shown) from the first or the first and second year's courses. Students so excused will nevertheless be required to undergo examination in all the subjects specified. The Certificate will state in which subjects the candidate has gained Honours, and in which he has merely satisfied the Examiners.

An ordinary degree of B.Sc. in Chemistry may be taken at the College in either two or three years, according as to whether the student passes the Preliminary Examination on joining the College or whether he takes a year to prepare for that examination. The Degree of B.Sc. with Honours in Chemistry can be taken in three years, and the College Certificate in Technological Chemistry may be taken in the same time.

A number of important Exhibitions, &c.. are available to students.

UNIVERSITY COLLEGE, NOTTINGHAM.

Department of Chemistry.

Professor of Chemistry—Frank Clowes, D.Sc. Lond., F.I.C., F.C.S.

Demonstrators.—J. B. Coleman, F.I.C., F.C.S., and R. L. Whiteley, F.I.C., F.C.S.

Lecturers.—J. B. Coleman, F.I.C., F.C.S., R. L. Whiteley, F.I.C., F.C.S., C. Haydon White, M.R.C.S., J. W. Carr, B.A., and F. R. Sargeant.

The Classes of the College are open to students of both sexes above sixteen years of age.

The dates of commencement and end of Terms in the Session 1888-9 will be as follows:—First Term, October 8th to December 22nd; Second Term, January 21st to April 6th; Third Term, April 24th to July 8th.

Lecture Courses.—The Chemistry Day Lectures extend over three years. In the first year a student enters for the course on Non-Metals for the first two terms and for Elementary Organic Chemistry in the third term. In his second year he takes the course on Metals for the first two terms, and Advanced Organic Chemistry in the third term. In his third year he attends a course on Applied Chemistry during the first two terms. Fee for Day Lectures and Classes, 50s. for the session of three terms: Non-Metals or Metals 42s.: Organic Chemistry (one term) 21s.: Applied Chemistry, 30s.

Demonstrations and Lectures on Analytical Chemistry will be given in the day and evening, and should be attended by all first year students.

A Chemical Calculation Class will meet on Friday Evenings at 7. Fee per term, 2s. 6d.

Students may qualify themselves by attendance at these lectures and classes for the Examinations of the Universities of London, Cambridge, or Oxford: they may also obtain instruction in Chemistry for technical or other purposes, and can enter for a full Chemical Engineering Curriculum. Special attention is given to the requirements of candidates for the Associateship of the Institute of Chemistry.

Practical Chemistry.—The chemical laboratory is open every day except Saturday from 10 to 5, on Saturday from 10 to 1, and on Tuesday and Thursday evenings from 7 to 9. Each Student works independently of other Students at a course recommended by the Professor. Instruction is given in general Chemical Manipulation and in Qualitative and Quantitative Analysis; and students are enabled to work out the applications of Chemistry to Pharmacy, Dyeing, Agriculture, Brewing, Iron and Steel, Tanning, and other Manufacturing Processes. Fees.—For one term, £6; for the session, £15; for day students for six hours weekly 40s., and 5s. extra for each additional hour per week. For evening students, 10s. for one evening per week, and 20s. for two evenings per week, per term.

Courses of Lectures are also given on the Chemistry of Dyeing and Bleaching, the Chemistry of Brewing, the Chemistry of the Coal Mine, and on many applied chemical processes.

A Pharmaceutical curriculum, extending over three Winter Sessions, includes Pharmaceutical Chemistry (lectures and laboratory work), Pharmaceutical Botany (lectures and class work on specimens), Materia Medica (lectures and use of specimens), and Practical Dispensing, taught by demonstrations and practical work in the laboratory.

Government Lectures and Classes.—Evening Lectures and Laboratory instruction will be given by the Demonrator of Chemistry to Students who intend to present themselves for Examination by the Government Science and Art Department in May next. Inorganic, organic, and practical chemistry, agricultural chemistry, and metallurgy will be taught in the elementary and advanced stages, each of which commences at the beginning of the College Session in October. Fees for each Lecture Course, 2s. 6d.; for each Laboratory Course, 10s. Students joining these classes are expected to become candidates for the Government Examinations in May.

Full information concerning all College Classes is given in the College Prospectus.

FIRTH COLLEGE, SHEFFIELD.

Professor of Chemistry.—W. Carleton Williams, B.Sc., F.C.S.

Demonstrator and Assistant Lecturer.—L. T. O'Shea, B.Sc., F.C.S.

The Session will commence on Tuesday, October 2, 1888.

First Year's Course.—Chemistry of the Non-Metallic Elements. Monday, Wednesday, Friday, from 10 to 11 a.m. Fee, £3 13s. 6d.

Second Year's Course.—Chemistry of Metals. Tuesday and Thursday, from 10 to 11 a.m. £2 12s. 6d.; or for the First and Second Courses, £5 5s.

Third Year's Course.—Organic Chemistry, on Wednesday, from 9 to 10, and Saturday, from 10 to 11. Fee, £2 2s.; Second and Third Courses together, £4 4s.

A Course of Lectures is arranged for Medical Students, with a special class in Qualitative Analysis.

Laboratory.—Working hours to be arranged between Professor and Students.

Sessional Fees for Day Students:—Six hours per week, £5 5s.; Nine, £7; Twelve, £8 8s.; Eighteen, £11 5s.: Twenty-four, £14; Thirty-two, £17.

Day Students may not enter for less than six hours a week. Students joining the Laboratory at Christmas will be charged two-thirds and at Easter one-third of the Fees for the whole Session.

Fees for short periods (working thirty-two hours per week):—For one month, £3 3s.; two months, £5 5s.

An arrangement has been entered into with the Science and Art Department, South Kensington, which will enable Science Teachers to work in the Chemical Laboratory for twelve hours a week on payment of one-quarter of the usual fee, the Department being willing to pay the remainder under certain conditions, of which full information may be obtained on application to the Registrar.

Evening Classes.—Lectures, Monday, 8 to 9. Laboratory instruction, Monday and Wednesday, 6 to 9. Sessional Fee, one evening per week, £1 10s.; two, £3; or Lecture Class and Laboratory, on Monday evening, £1 10s.

UNIVERSITY COLLEGE, DUNDEE.

Professor.—T. Carnelley, D.Sc., F.C.S.

Lecture Assistant.—Andrew Thomson, M.A., D.Sc.

The sixth session of the College will be opened on October 8th, 1888.

The Lectures and Laboratory practice in Chemistry are recognised by the Royal College of Physicians and Royal College of Surgeons, London, and by the Royal College of Surgeons, Edinburgh, and for degrees in Science and Medicine by the University of St. Andrews and Edinburgh.

The courses are suitable for the Degrees of the London University and for the Civil Service appointments, and will also satisfy the requirements of students in Pharmacy, and of students who intend to become candidates for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

Lecture Courses.

The object of these courses will be (1) to give systematic instruction in the general principles of the science, and information regarding the elements and their more important compounds; (2) to show how this knowledge may be usefully applied in the Arts and Manufactures.

A course of instruction in Practical Chemistry in the Laboratory is recommended to all who wish to obtain a sound knowledge of the science, and the methods of applying it to useful purposes—the duration of such course depending upon the special wants of the student.—The Professor will be glad to give any information to intending students.

First year's lecture course: Monday, Wednesday, and Friday, from 10 to 11 a.m.; fee, £2 2s.

Second year's lecture course: Tuesday, Thursday, and Saturday, from 9 to 10 a.m.; fee, £2 2s.

A Lecture Course on Analytical Chemistry will be given on Wednesdays, from 9 to 10. Fee, £1 1s.

Courses of lectures will be given on Dyeing, Bleaching, and the Chemistry of the Textile Fibres, with practical instruction in the Laboratory. In connection with this Department there is an extensive Technical Museum, containing a large collection of specimens illustrating many branches of Applied Chemistry, and particularly the local industries.

Practical Chemistry (Laboratory).

The aim of the Laboratory Courses is to make the student practically acquainted with the science, so that he may conduct chemical analysis and original research, and generally to fit him for applying the science to the Arts, Manufactures, and Agriculture. The courses are also suitable for students preparing for their medical and pharmaceutical examinations. A three months' course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health, may be taken in the College Laboratory.

The Laboratory will be open for students daily from 9 a.m. to 4 p.m., except on Saturdays, when it will be closed at 3 p.m. Each student on entering will be allowed to arrange his working hours to suit his own convenience, but will be required to keep the hours when once fixed.

Sessional Fees for Day Students:—The fees for both sessions are—for six hours per week, £3 3s.; each additional hour per week, 10s. 6d. Day students may not enter for less than six hours a week. Students joining the Laboratory during the second term will be charged two-thirds, and during the third term one-third of the above fees. Students may also enter for short periods, working every day in the week at the following fees:—For one month, £2 12s. 6d.; for two months, £5 5s.; for three months, £7 7s.

Evening Classes.—Courses of Lectures and Practical Laboratory instruction.

UNIVERSITY OF EDINBURGH.

Professor.—A. Crum Brown, F.R.S.E.

Two degrees in Science are conferred by the University of Edinburgh, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.). Both these degrees are conferred in Physical and Natural Science, in Public Health, and in Engineering.

Candidates for degrees in Physical and Natural Science must pass a preliminary examination in English, Latin, Arithmetic, the Elements of Mathematics, and the Elements of Mechanics, and in at least two of the following subjects:—Greek, French, German, Higher Mathematics, Natural Philosophy, Logic, and Moral Philosophy.

The First B.Sc. Examination embraces Mathematics, Natural Philosophy, Chemistry, Zoology, including Comparative Anatomy, and Botany. The Second B.Sc. Examination the Higher Mathematics, Experimental Physics, Chemistry, Zoology, Botany, Physiology, and Geology, including Palæontology and Mineralogy.

The D.Sc. Examination embraces Mathematics, Natural Philosophy, Applied Mathematics, Experimental Physics, Practical Astronomy, Chemistry, Zoology and Comparative Anatomy, Animal Physiology, Botany, and Geology, including Palæontology and Mineralogy.

GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE.

The main objects of this College are to afford a suitable education to those who wish to qualify themselves for following any industrial profession or trade, and to train teachers for technical schools. It was founded by an Order in Council, dated 26th November, 1886, according to a scheme famed by the Commissioners appointed under the provisions of the Educational Endowments (Scotland) Act, whereby Anderson's College, the Young Chair of Technical Chemistry in connection with Anderson's College, the College of Science and Arts, Allan's Glen's Institution, and the Atkinson Institution were placed under the management of one governing body.

The Diploma of the College will be awarded to Day Students who have attended the courses of instruction and passed the necessary examinations. The ordinary courses will extend over three years, but arrangements will be made for advanced students continuing their studies in special departments.

The Chemical Laboratory (Prof. Dittmar's) opened on September 3rd. The Lecture Courses commence on October 1st.

Copies of the Calendar for 1888-9 may be had from Mr. John Young, B.Sc., the Secretary, 38, Bath Street, Glasgow, price, 1s.

The Courses of Lectures, &c., are given at various places as follow:—

Andersonian Buildings, Glasgow.

Professor of Chemistry.—William Dittmar, LL.D., F.R.SS. Lond. and Edin.

Chief Assistant.—Archibald Kling, F.I.C.

Laboratory Assistants.—Frank Lyall, James Robson, and William Cullen.

Junior Assistants.—Andrew Reid and Andrew Hodge.

A Course of Experimental Lectures on Chemistry: Daily from 10 to 11. The Lectures up to the end of the year are devoted to an Elementary Exposition of the Philosophy and the Methods of the Science, as illustrated by the History of the Non-metallic Elements. The rest of the Session is divided between the Chemistry of the Metals and Organic Chemistry, select chapters. In addition to occasional extemporised examinations during class hours, five written examinations are held during the Session, on Saturdays from 10 to 12. Fee, £2 2s.

The Laboratory is open daily (Saturdays excepted) from 10 to 5. Advanced students may obtain permission to work privately on Saturdays also until 1 p.m. The teaching is conducted on the tutorial system, each student working by himself, at a separate place, and on his own subject. Hence students of any grade of advancement may enter at any time, and the course of instruction can be adapted to the special requirements of the individual. Original research is not forgotten, but the Professor makes it a strict rule not to use his students as his private assistants in connection with his own in-

vestigations, and rather to discourage original research with students who have not yet obtained a sufficient mastery of all the practically important methods of chemical analysis and of preparative chemistry. Fee per month, £2 2s.; due in advance. For any period of six months or more, if paid in advance, at the rate of £1 15s. per month. The fees include the use of all the ordinary reagents, and of the resources of the laboratory generally; but the student has to find his own small apparatus (test-tubes, beakers, &c.), and also a few of the more expensive reagents—*e.g.*, chloride of platinum, nitrate of silver, molybdate of ammonia.

Supplementary Courses of Lectures and Laboratory Instruction are also given by the Assistants under the superintendence of the Professor.

The "Young" Chair of Technical Chemistry, Young Laboratory Buildings.

Professor.—Edmund J. Mills, D.Sc. (Lond.), F.R.S.
Assistant.—Mr. William Baird.

This Chair has for its object the instruction of Students n Chemistry as applied to the various branches of industry in Chemical and other works.

Lectures.—*Principal Course.*—A Course of Twenty-four Lectures will be delivered on Mondays and Tuesdays, at 3 p.m., commencing on October 1st. These Lectures will refer mainly to the application of higher Chemistry, and are more especially intended for manufacturers, inventors, chemical engineers, and senior chemical students. Fee for the Course, One Guinea.

Subsidiary Course.—A subsequent Course of Twenty-one Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 3 p.m. This Course is more particularly intended for Dyers, Colour Manufacturers, Brewers and Distillers, Tar Rectifiers, Drysalters, and others interested in a knowledge of Technical *Organic* Chemistry. Fee for the Course, £1 1s.

Evening Courses.—There will be a special evening course of twenty-four lectures on Bleaching, Dyeing, and Printing, commencing on October 1st.

There will be Practical Evening Classes in the following subjects:—Oils, Paints, and Varnishes; Bleaching, Dyeing, and Printing, &c.

Laboratories.—The Laboratories are open daily from 10 to 4, and on Saturday from 10 to 1 o'clock for practical working by the Students, under the superintendence of the Professor and his Assistants.

The Fee for attending the Laboratories is £20 per Session of Nine Months, £14 10s. for Six Months, £7 10s. for Three Months, or £2 10s. per month.

Inventors, Patentees, and others whose investigations require isolation and privacy, as well as professional advice, can have Private Laboratories placed at their disposal. Electric Cable has been laid to these laboratories for the supply, if required, of adequate power.

Agricultural Chemistry.—Mr. C. M. Aikman, M.A., B.Sc., &c., will give courses of Evening Lectures on this subject. Elementary, Tuesdays, at 7. Senior, Fridays, 7 to 9.

Further information may be obtained of the Professor, at the Young Laboratory, 60, John St., Glasgow.

Science and Art Buildings.

Metallurgy and Mineralogy.—Professor, A. Humboldt Sexton, F.R.S.E., &c. Assistants: J. Morrow Campbell, B.Sc., and R. Law.

A course of lectures on Metallurgy on Mondays, Wednesdays, and Fridays, at 10 o'clock. Fee, £2 2s.

The Metallurgical Laboratory is open daily from 10 to 1.30. Instruction is given in all branches of practical Metallurgy and Assaying. Fee for the session, £6 6s.

A course of instruction in Mineralogy, including the use of the blowpipe, &c., is given on Tuesdays and Thursdays from 12 to 1. Fee, £1 1s.

Evening classes in Chemistry, Metallurgy, and Mineralogy commence on Monday, October 1st.

UNIVERSITY OF ST ANDREWS.

United College of St. Leonard and St. Salvator.

Professor of Chemistry.—T. Purdie, B.Sc., Ph.D., Assoc. R.S.M.

The Session begins on October 30th. A Competitive Examination, open to intending Students of Arts or Science, for fifteen Entrance Bursaries, ranging in value from £30 to £10 each per annum, will be held on Friday and Saturday, October 26th and 27th. Two Degrees in Science are conferred by the University of St. Andrews, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.), the regulations regarding which will be found in the "University Calendar."

Lecture Course.

A Lecture is delivered by the Professor of Chemistry, at 11 o'clock, on five days in the week throughout the Winter Session. The Course commences with the study of a few typical substances, forming an introduction to the discussion of Chemical Theory; the Non-metallic and Metallic Elements, with their chief compounds, are then considered; and the latter part of the Course is devoted to Elementary Organic Chemistry. Three Lectures weekly are of an elementary character, and are intended to be useful to Students of Arts who desire to study Chemistry as a branch of general education, or with the view of teaching it in schools; the remaining two Lectures weekly constitute a Supplementary Course, framed so as to meet the additional requirements of Candidates for the Degree of Bachelor of Science and of Medical Students.

Certificates are awarded on the results of separate examinations on the subjects of the general and supplementary Lectures.

Fee for the Session, £3 3s.

Laboratory Course.

A class in Practical Chemistry meets for two hours weekly, to which Students attending the Lectures are admitted without additional fee. The Course consists of a series of qualitative and quantitative experiments, designed to give the Student a practical acquaintance with the principles of Chemistry regarded as a subject of general education.

The Laboratory is also open during the Session from 10 a.m. to 4 p.m., for instruction in Chemical Analysis. The fee is £10 10s. for the Session. Shorter Courses of Practical Chemistry will be arranged to meet the requirements of Students who cannot give so much time to the subject, the fees for which vary according to the number of hours taken weekly.

Several free places in the Laboratory will be given to Students desirous of engaging in original work. Applicants must satisfy the Professor that their studies are sufficiently advanced to admit of them prosecuting experimental research.

QUEEN'S COLLEGE, BELFAST.

Professor.—E. A. Letts, Ph.D., F.R.S.E., F.C.S.

I.—*Chemistry.*—The lectures are delivered at 3 p.m., on the first five days of each week until the beginning of April, and on two days of each week after May 1st. The course is divided into three parts:—(1) Chemical Philosophy; (2) Inorganic Chemistry; (3) Organic Chemistry.

II.—*Advanced and Organic Chemistry.*—Lectures on these subjects are given from the beginning of the Session, on Tuesdays and Thursdays, at 10 a.m., until the beginning of April, and at 3 p.m. after May 1st.

III.—*Practical Chemistry.*—In this course the Students are instructed in the general methods of conducting Chemical Analyses.

IV.—*Laboratory Pupils.*—The Chemical Laboratory is open from November until the beginning of April, and from May 1st until the middle of July, on the first five days of the week, from 10 a.m. until 4 p.m. Students are admitted as working pupils on payment of a fee of £5

for the first period, or of £3 10s. for the second period (or for a single term).

QUEEN'S COLLEGE, CORK.

Professor.—Maxwell Simpson, D.Sc., M.D., F.R.S., &c.

The Course is divided into Inorganic and Organic Chemistry.

In the first part are discussed the Laws of Combination and Affinity, Molecular Chemistry and Crystallography, and the History of the Non-Metallic and Metallic substances.

In the Organic portion of the Course will be considered the subjects of Organic Analysis, Organic Series, Compound Radicals and Types, Metamorphosis of Organic Bodies, History of Special Animal and Vegetable Bodies.

In treating of the Laws of Chemistry, and the History of Inorganic and Organic Bodies those points will be chiefly dwelt upon which have a practical bearing in the Arts, Medicine, Engineering, and Agriculture. Thence, during the Course, attention will be directed to the application of Chemistry to Medicine and Physiology, to Metallurgic Operations, Chemical Manufactures, Building Materials, Soils, and Manures.

Fee.—For each Sessional Course, £2. Each subsequent Course in Medicine, £1.

The Chemical Laboratory is open daily except on Saturdays, from 10 to 4 o'clock, under the Superintendence of the Professor, to Students desirous of prosecuting an extended course of qualitative and quantitative analysis, and for the purpose of original investigation in connection with the Arts, or in the higher departments of Scientific Chemistry.

ROYAL COLLEGE OF SCIENCE FOR IRELAND, Stephen's Green, Dublin.

Professor of Practical and Theoretical Chemistry.—W. N. Hartley, F.R.S.

The Session commences on Monday, October 1, 1888.

The instruction comprises courses of Lectures on General, Applied, and Analytical Chemistry, and also a course of Lectures on Metallurgy.

The Chemical and Metallurgical Laboratories, under the direction of Professor Hartley, are open every weekday during the Session. Instruction is given in the different branches of Analytical Chemistry, including Assaying, and in the methods for performing Chemical Research. Fee, for the Session of nine months, £12; for six months, £9; for three months, £5; for one month, £2. Fee for a course of assaying not less than £5.

There are four Royal Scholarships of the value of £50 each yearly, with Free Education, including Laboratory Instruction, tenable for two years; two become vacant each year; they are given to Associate Students, not being Royal Exhibitioners, who have been a year in the College on the results of their examinations. There are also nine Royal Exhibitions attached to the College, of the yearly value of £50 each, with Free Education, including Laboratory Instruction, tenable for three years; three become vacant each year, and are competed for at the May Science Examinations of the Department of Science and Art.

A Diploma of Associate of the College is granted at the end of the three years' course.

Evening Classes.—Courses of Evening Lectures are occasionally given by the Professors during the Session.

CHEMICAL LECTURES, CLASSES, AND LABORATORY INSTRUCTION.

City and Guilds of London Institute for the Advancement of Technical Education.—*Central Institution, Exhibition Road.*—Professor of Chemistry, H. E. Armstrong, Ph D., F.R.S. This Institution is intended to afford such practical, scientific, and artistic instruction as shall qualify persons to become—(1) Technical teachers; (2) Mechanical, civil, and electrical engineers, architects, builders, and decorative artists; (3) Principals, superintendents, and managers of chemical and other manufacturing works. Prominent among the agencies adopted is a scheme of Technological Examinations, in connection with which a large number of classes have been instituted in the various manufacturing centres of the kingdom at which practical instruction is given in the application of Science and Art to different industries. The work done in these classes is inspected by the Institute, and, on the results of the annual examinations, certificates and prizes are granted. The Matriculation Examination will be held on Tuesday, September 25th. *Technical College, Finsbury.*—Professor of Chemistry, Raphael Meldola, F.R.S. The College fulfils the functions of a finishing technical school for those entering industrial life at a comparatively early age; of a supplemental school for those already engaged in the factory or workshop; and of a preparatory school for the Central Institution. It is under the general direction of the Principal or Superintendent of Studies. At the head of each Department is a Professor, who is assisted by one or more Demonstrators; and besides these there are Lecturers and Teachers for instruction in special subjects: Skilled Artizans are employed in the Workshops for the guidance of the Students. The Session is divided into three terms:—The Winter term commences on Tuesday, October 2nd. An examination for the admission of Students will be held at the College at 10 o'clock on Wednesday, September 26th, 1887, and the work of the Session will commence on October 4th. The instruction consists of Day and Evening Classes and Laboratory Instruction.

Birkbeck Literary and Scientific Institution, Bream's Buildings, Chancery Lane.—*Organic Chemistry:* On October 3rd Mr. F. Gossling, B.Sc., will commence (1) at 7 p.m. a course of Elementary Lectures; and (2) at 8.15 p.m. a Course of Advanced Lectures, the latter being adapted for the preparation of Students for the final B.Sc. (London) Examination. Laboratory practice and analysis will commence on the 5th October. Courses will be conducted adapted for the Elementary, Advanced, and Honours Examinations of the Science and Art Department, and for the Pass and Honours Courses of the 2nd B.Sc. *Inorganic Chemistry:* Mr. G. Chaloner, F.C.S. Lectures—Elementary, Tuesdays, 8.30 p.m.; Advanced, Saturdays, 9 p.m.; Practical, Tuesdays, 6—8 p.m.; Thursdays, 7—9 p.m.; Saturdays, 7—9 p.m.

School of Pharmacy of the Pharmaceutical Society of Great Britain, 17, Bloomsbury Square.—The school opens on Monday, the 1st of October. Lectures on Chemistry and Physics, by Prof. Wyndham Dunstan, on Monday, Tuesday, and Wednesdays, at 9 a.m. Lectures on Botany by Professor Green, on Friday and Saturday mornings at 9. Demonstrations in Materia Medica by Mr. Holmes, Curator of the Society's Museums, on Thursdays at 10 a.m. Lectures and Demonstrations in Pharmacy and Practical Pharmacy by Mr. Ince, on Tuesday, Thursday, and Friday, at 5 p.m. The Laboratories for Practical Instruction in Chemistry as applied to Pharmacy, &c., under the direction of Prof. Attfield, assisted by Mr. F. W. Short, will be open daily at 10 a.m. throughout the Session. They are fitted up with every convenience for the study of the principles of Chemistry by personal experiment. They are specially designed for the student of Pharmacy but are equally well adapted for the acquirement of a knowledge of Chemistry in its application to Medicine, Manufactures, Analysis, or Original Research. There is no general class for simultaneous instruction, each student following an independent course of study always determined by his previous knowledge; pupils can therefore enter for any period at any date. Fees for the Lectures: Chemistry, First Course, £4 4s.; Second Course, £2 2s.; an entire Session—Two Courses, £5 5s. Botany—First Course, £3 3s.; Second Course, £2 2s.; Session, £4 4s. Pharmacy—One Course, £2 2s. For Practical Chemistry,

10 months, 12 to 25 guineas, according to hours of attendance. *Council Prizes.*—At the end of the First or Winter Course a Bronze Medal and two Certificates of Honour, and at the close of the Session a Silver Medal and three Certificates of Honour areoffered for competition by the Council. In the Class of Practical Chemistry, a Silver Medal, Bronze Medal, and five Certificates of Honour, are offered by the Council for competition. In the Materia Medica and Pharmacy Classes a Bronze Medal is offered for competition at the end of each Course, and a Silver Medal at the end of the Session.

Charterhouse Science and Art Schools.—Classes are established in this institution by which instruction of a practical character is given in most of the Sciences at a very nominal fee; whilst in Art, at an equally low rate, Students, under the direction of five competent instructors, can be advanced in their studies. Those who have leisure can, at a very moderate charge, attend the Day Classes in Art. Day Classes will also be held to prepare Candidates for Matriculation (Lond.), the Clerical, Medical (including Dental), Legal, and other Examinations. Students who aim at becoming proficient in Chemistry (Organic and Inorganic) have the opportunity of working in a well-fitted Laboratory, capable of accommodating sixty Students. Aspirants of University Honours can at a small expense be assisted in their studies.

The City School of Chemistry and Pharmacy, 27, Chancery Lane, London, W.C.—Principal, Mr. Maurice Williams. Theoretical and Practical Chemistry, Chemical Physics, Theoretical and Practical Pharmacy, Materia Medica, Therapeutics, and Toxicology.

New Central School of Chemistry and Pharmacy' 173, Marylebone Rd., London.—Mr. J. Woodland, F.C.S., In addition to the usual Chemical studies, Special Instruction Classes are held for Students of Medicine.

South London School of Pharmacy, 325, Kennington Road, S.E.—This School opened on September 12th, and the Session lasts until July 15th, 1889. Lectures on Chemistry and Physics, by Dr. John Muter, F.R.S.E., F.I.C., Daily, at 9 a.m. (Organic) and 10 a.m. (Inorganic). Lectures on Botany daily at 12 noon, and at 2 p.m. on Materia Medica and Pharmacy, by Mr. Dodd, F.C.S. The Laboratories for Qualitative and Quantitative Analysis open daily from 9 till 5, under the direction of Mr. de Koningh, F.I.C., F.C.S, assisted by Mr. Armstrong. The Students' Laboratory of this Institution is specially designed to accommodate 40 Students. The Technical Laboratory is open daily from 9 till 4, and is fully fitted with all apparatus for teaching the manufacture of drugs and chemicals. Periodical Examinations of the Students are held by Visiting Examiners appointed by the Council of Education, and Medals and Certificates are awarded on the results thereof. Fees for the first three months £10 10s. (junior) and £12 12s. (senior); afterwards £2 2s. and £3 3s. per month respectively, inclusive of all departments. Technical Laboratory, £3 3 per month extra.

Onslow College of Science, 183, King's Road, Chelsea, S.W.—Lectures and Laboratory instruction in Chemistry and Pharmacy. Special Evening Classes in Inorganic and Organic Chemistry, &c. The Chemical and Metallurgical Laboratories are open every day and evening for practical work. Principal, Mr. W. H. Martin.

Royal Victoria Hall, Waterloo Bridge Road, S.E.—Science and Technical Classes, Session 1887-88. Lectures will be given in the following subjects:—Electricity and Magnetism, Mr. L. H. Owen; Animal Physiology, Dr. Drew, B.Sc.; and Chemistry, Dr. Forster Morley and Mr. E. E. Graves. Classes are also held in Mathematics, Plane and Solid Geometry, Machine Construction and Drawing, Applied Mechanics, Shorthand, and Arithmetic. The instruction given is suited to artizans and practical men, and is chiefly in connection with the Science and Art Department, South Kensington.

Portman School of Pharmacy, 156, Marylebone Road, Regent's Park.—Principal, Mr. F. H. Painter.

CHEMICAL LECTURES AT LONDON HOSPITALS.

Chemical Schools and Colleges.	Winter Session.				Summer Session.			
	Lecturers on Chemistry.	Days and Hours.	Fees. One Course.	Fees. Perpetual.	Lecturers on Chemistry.	Days and Hours.	Fees. One Course.	Fees. Perpetual.
			£ s.	£ s.			£ s.	£ s.
St. Bartholomew's Hosp. and College	Dr. Russell, F.R.S.	M. W. F., 9	6 16/6	9 9	Dr. Russell	M. Tu. F., 11 [to 1	3 3	
Charing Cross Hospital and College	Mr. Heaton	M. W. F., 4	6 6		Mr. Vasey	M. Th. 2 to 4	5 5	
St. George's Hospital ..	Mr. Donkin	Tu. Th. S., 11	6 6	7 17/6	Mr. Donkin	M. W. F., 11	4 4	
Guy's Hospital	Dr. Debus, F.R.S., and Dr. Stevenson	Tu. Th. S., 11	7 7		Mr. Groves	M. W. F., 10 to 1	7 7	
King's College and Hosp.	Mr. Thomson, Mr. Johnson, and Mr. Jackson.	M. W. Th., 10¼	8 8	11 11	Mr. Thomson, Mr. Johnson, & Mr. Jackson	M. W. Th., 10¼	6 6	8 8
London Hospital	Dr. Tidy	M. W. F., 10.30	7 7	10 10	Mr. Page	M. W. S.	5 5	
St. Mary's Hospital ..	Dr. Wright	W. S., 10 and 11	6 6		Dr. Wright	W. F. S., 9	4 0	
Middlesex Hospital ..	Mr. W. Foster	M W. Th. Fr., 3	8 8		Mr. W. Foster	M. W. F., 3	4 4	
St. Thomas's Hosp. & Schl.	Dr. Bernays	Tu. Th. F., 10¼	7 7		Dr. Bernays	M. Th. F., 10	6 6	
University Col. & Hosp.	Dr. Ramsay and Dr. Plimpton.	Daily (ex. W.), 10	6 6	10 10	Dr. Ramsay	S., 10	5 5	
Westminster Hospital ..	Dr. Dupré, F.R.S.	W. Th. F., 3	6 6	8 8	Dr. Hake	M. W. F., 11	4 4	

Westminster College of Chemistry and Pharmacy, Trinity Square, Borough, S.E. — Messrs. Wills and Wootton.

Bristol Medical School.—Mr. T. Coomber, F.C.S.

Institute of Chemical Technology, Hackins Hey, Liverpool.—Principal, Mr. A. Norman Tate, F.I.C. The course of instruction is intended more especially for students who wish to gain a knowledge of chemistry and the allied sciences in their relation to industrial and commercial pursuits, and embraces a thorough preliminary course of theoretical chemistry and practical laboratory work, followed by instruction in chemical technology fitted to the requirements of each pupil. In addition to these chemical studies, students who desire it can enter upon a special course calculated to afford them knowledge useful in the erection and arrangement of manufactories and plant, and construction of apparatus.

Leeds School of Medicine.—Prof. Smithells.

Leeds School of Science and Technology.—Mr. J. Wertheimer, B.Sc., F.C.S., and Mr. E. Rawlins, F.C.S.

Newcastle-on-Tyne School of Science and Art and Technical College (Chemical and Metallurgical Department).—Principal, P. Hawkridge, B.A. Lecturers and Demonstrators, W. D. Oliver, H. Oliver, J. D. Best, &c. Classes will be held in the Day School and in the Evening Classes in all stages of Inorganic and Organic Chemistry, and the Laboratories will be opened for practical work, including Qualitative and Quantitative Analysis. Classes will also be held in Metallurgy, both Theoretical and Practical.

Sheffield Borough Analysts' Laboratory, 1, Surrey Street.—Mr. A. H. Allen, F.C.S. Day and Evening Classes.

Sheffield Mechanics Institution, Tudor Street.—Lecturer on Chemistry, Henry J. Hardy, F.C.S., &c. The Course is divided into Organic and Inorganic Chemistry. About 30 Lectures are given in each. The Session commenced September 10th.

University of Aberdeen.—Mr. J. S. Brazier, F.C.S.

School of Medicine, Surgeon's Hall, Edinburgh.—Dr. Stevenson Macadam, F.R.S.E., Mr. Falconer King, Mr. Ivison Macadam, and Mr. Drinkwater.

Edinburgh School of Pharmacy and Chemistry.—The instruction qualifies for graduation in Medicine and Science in the University of Edinburgh and other Examining Boards. Secretary, Mr. R. Urquhart.

Edinburgh School of Medicine, 41, Chambers St.—Dr. Drinkwater, F.C.S.—The instruction here qualifies for all Medical Boards, Edinburgh University, London University, &c. Day and Evening Classes.

Minto House Medical School, Chambers Street, Edinburgh.—Mr. J. Falconer King, F.I.C., F.C.S. Lectures and Classes.

New Veterinary College, Leith Walk, Edinburgh.—Professor Ivison Macadam.

Glasgow University.—Prof. J. Ferguson.

Glasgow Veterinary College.—Professor Cooke.

School of Chemistry, 138, Bath Street, Glasgow.—Dr. Wallace, Mr. Tatlock, and Dr. Clark. Day and Evening Classes.

Chemical Laboratories and Class Rooms.—Messrs. R. R. Tatlock and Readman, City Analyst's Laboratory, 156, Bath Street, Glasgow; and India Buildings, Edinburgh. Winter Session from October to March, and Summer Session from May to July, inclusive. Hours of attendance in Laboratory from 10 till 4 daily. Courses of Lectures will be delivered on the laws and principles of Chemical Science and Laboratory Practice during the Winter Session. Evening Class for Commercial Analysis on Monday Evenings from 7 to 9, beginning on October 8.

Royal Infirmary Medical School, 86, Castle Street, Glasgow.—Chemical Department: Dr. Milne, F.I.C. The Winter Session for Practical Chemistry begins on October 1st, and the Course of 100 Lectures on Inorganic and Organic Chemistry on October 28. Syllabuses of Day and Evening Courses of instruction may be had on application.

Queen's College, Galway.—Dr. T. H. Rowney.

Royal College of Surgeons in Ireland, Dublin.—Professor of Chemistry and Hygiene: Sir Charles A. Cameron, M.D., F.R.C.S.I. Instruction is given in the College Laboratory in General, Practical, and Analytical Chemistry, and in the subjects (Physical, Chemical, and Microscopical) required for Examinations in Public Health and to educate for the position of Public Analyst.

North City School of Science and Technology, Mechanics' Institute, Lower Abbey Street, Dublin.—Evening Classes: Mr. Clement J. Leaper.

Dublin, Carmichael College of Medicine.—Professor of Chemistry: C. R. C. Tichborne, Ph.D., F.C.S.

Dublin, Catholic University.—Dr. Campbell.

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1505.

THE THEORY OF SOLUTION.*

By T. STERRY HUNT, LL.D., F.R.S.

1. The late inquiries of Mendeleeff into the nature of solution made known by him since 1886 have deservedly attracted attention, for the reason assigned by him in a recent paper on "The Compounds of Ethyl Alcohol with Water" (*Trans. Chem. Soc.*, October, 1887, p. 778). He there observes that while "the views of chemists respecting the relations between the ordinary cases of chemical combination and the phenomena of dissolution remain still undefined, the part played by solution in nature . . . . is so important that the fulness of our chemical conceptions seems to suffer from the want of clearness in the doctrine relating" to these phenomena. He adds, "without describing the methods by which I have arrived at my views on the nature of solutions, . . . I shall now state the hypothesis which is in accordance with them. Solutions may be regarded as strictly definite chemical combinations." He again insists upon "the existence in solution of definite combination," and continues, "I intend to investigate minutely solutions of low temperatures, and I expect to obtain definite compounds in the solid state, and to explain the relations of these solid compounds, which were obtained by me in 1868, and afterwards by Guthrie, who called them cryohydrates."

Believing that the presence in solutions of such definite hydrates could be detected by studying the changes in density in relation with centesimal composition, Mendeleeff has with success applied this method to the investigation of the liquids got by diluting with water both alcohol and sulphuric acid. In this way he has obtained evidence that not less than three definite hydrates of alcohol and water, represented respectively by $C_2H_6O.12H_2O$, $C_2H_6O.3H_2O$, and $3(C_2H_6O).H_2O$, may exist in solution, from which they may be separated by reduction of temperature. Of these hydrates the first is got in a solid state at $-17°$, and the second at a still lower temperature. He further concludes that for sulphuric acid and water there are not less than four definite compounds in which $S.H_2O_4$ is combined respectively with H_2O, $2H_2O$, $6H_2O$, and $150H_2O$. Other portions of Mendeleeff's explanations apparently refer to the fact (hereafter to be noticed) that such combinations as these, in which water is the solvent, are disturbed by changes of temperature, which destroy the chemical equilibrium, but the language is somewhat obscure.

That these views lately put forth by Mendeleeff in the paper here cited in Oswald's *Zeitschrift für physikalische Chemie*, 1887, p. 379, and in various communications to the Russian Chemical Society, are considered to be important by chemists is shown by the late remark of Crompton, who probably expresses a very general opinion when he declares that as "a consequence of Mendeleeff's original treatment of the subject, our conception of the constitution of solutions has suddenly acquired a degree of precision which is altogether remarkable when the nature of the problem is considered" (*Trans. Chem. Soc.*, Jan. 1888, p. 116).

2. As a contribution to the theory of solution the writer may be permitted to recall to the notice of chemical students his essay entitled "Thoughts on Solution and the Chemical Process," published more than a third of a century since in the *American Journal of Science* for January, 1855, and the *Chemical Gazette* for the same year, and reprinted in his *Chemical and Geological Essays* (1874 and 1878, pp. 448—452). Therein, after showing the vague and uncertain notions as to the nature of solution held by Berzelius, Dumas, and Mitscherlich, and noting that Turner and Griffin had, among others, affirmed the chemical nature of solution, the author announced as his thesis not only that solution is chemical union, but that "all chemical union is nothing else than solution. The uniting species are, as it were, dissolved in each other, for solution is mutual." The same idea was subsequently expressed in 1874 by saying, "The type of the chemical process is found in solutions, from which it is possible, under changed physical conditions, to regenerate the original species." He had already said in 1853, "Solution is the result of that tendency in nature which constantly leads to unity, condensation, and identification." And further, "Solution is chemical union, as is indicated by the attendant condensation."

In support of this doctrine it was pointed out in the essay of 1855 that "aqueous solution presents all the phenomena of chemical combination;" among which were then enumerated "homogeneousness," "more or less perfect identification of volume," "the changes of temperature which attend the process," and the "changes of colour" seen in the solution of some compounds, as in the case of the chlorides of copper and nickel. It was further noted that "the liquid state of these combinations is often an accident of temperature. Alum and the rhombic phosphate of soda [$Na_2HPO_4.10H_2O$] are liquids at 212° F., and the bihydrated sulphuric acid [$H_2SO_4.2H_2O$, now cited by Mendeleeff] is a crystalline solid below 46° F." This was followed by an argument to the effect that the instability of some of these hydrous compounds is not to be urged against their chemical nature, "since chemical affinity may be very feeble in degree." It was further said, "the precipitation of the [hydrated] sulphates of cerium, lanthanum, and calcium from their solutions by heat, and that of most other salts by cold, is chemical decomposition."

3. The case of arsenic terchloride was then noticed, which unites with a certain amount of water, yielding a well defined solution, and subsequently, by the addition of a larger amount, is dissociated in a different sense, so as to give chlorhydric acid and arsenic teroxide, thus illustrating the theory of double decomposition. The capacity of sulphuric acid to combine with a great amount of water was next considered, Gay Lussac, it was said, having shown that this acid will absorb from an atmosphere saturated with moisture fifteen times its own weight, while, according to the investigations of J. J. Griffin (*L. E. and D. Philos. Mag.* (3), xxix., 299), the condensation which is known to attend the union of sulphuric acid with water is still perceptible with 6000 equivalents of water to one of acid. It was then added, "there appears, however, to be with many bodies a limit beyond which the affinity for water is satisfied. The liquids, being then mechanically intermixed, gradually separate by reason of their difference in density, as is observed in dilute alcohol, and probably in some saline solutions and in metallic alloys." Reference was then made to the statements on this point to be found in "Gmelin's Handbook of Chemistry" (Cavendish Society's Ed., i., p. 111) and also to some later statements with regard to the asserted separation of dilute alcohol into layers of greater or less hydration. The many alleged cases of such separations in aqueous liquids present a problem the settlement of which will constitute an important contribution to the theory of solution.

The recent studies of Traube and Neuberg (*Zeit. Physikalisch Chem.*, i., 509—515) have confirmed the previous observations of Bodländer, showing that solutions of ammonium sulphate in dilute alcohol separate spontaneously by augmentation of temperature into layers of unlike densities, the proportion of alcohol increasing and those of water and sulphate decreasing in the upper layer. Similar results were got with alcoholic solutions

* Read before the British Association, Bath Meeting, Section B.

of other sulphates, with phosphates and carbonates, and with the hydroxides of potassium and sodium.

4. The theory of solution, as put forward by the author in January, 1855, and ever since maintained by him, embraces then:—1st. The conception that in the process of aqueous solution there are formed definite compounds with water, accompanied with all the phenomena of chemical union. 2nd. That in these compounds of a single proportion of a salt or other species with many proportions of water, there are definite limits beyond which the further addition of water gives rise (A) to decomposition, involving a new arrangement of the elements of the previously united bodies (double decomposition), or (B) to simple admixtures of one definite solution or liquid species, with another less dense solution, or with water. 3rd. That these compounds are separable in a solid state by changes of temperature, or (theoretically at least) in a liquid state by the influence of gravity. 4th. That liquidity is but an accident of solution, since it is a state depending on temperature and on pressure, which state may be assumed by all species, whether elemental or compound.

Mendeleeff, who has now arrived at similar views of the nature of solution—at least so far as aqueous solutions are concerned—has contributed to the subject an important means of investigating such solutions by the study of their specific gravities in connection with their centesimal composition. He has at the same time suggested that the existence of the various hydrates in aqueous solutions should be made evident by other physical properties than density, a suggestion which has been successfully followed up by Crompton in his recent paper, already cited, on "The Electrical Conductivity of Aqueous Solutions" (*Trans. Chem. Soc.*, Jan., 1888). Therein, by his mathematical investigation of the relation between the conductivity of more or less dilute sulphuric acid and its composition, he obtains a close concordance with the results of Mendeleeff, and concludes that "the electrical conductivity of sulphuric acid, if not wholly due to, is very largely influenced by, the formation of definite hydrates in solution." Similar conclusions are deduced by him from the application of the same method to dilute phosphoric, nitric, and acetic acids, and to the solutions of potassium and sodium hydroxides; for all the details of which, as well as for Prof. H. E. Armstrong's appended discussion of Crompton's results, the reader is referred to the *Transactions of the Chemical Society* as already quoted.

5. In the author's late volume, entitled "A New Basis for Chemistry" (Boston; 1st Ed., 1887; 2nd Ed., 1888), the question of solution has been considered in several places. Thus, in Chapter II., §12, there will be found most of the citations already given from his papers of 1853, 1855, and 1874. Further on, in Chapter XII. (§§71—73), the recent views of Guthrie and of Spencer Pickering on so-called molecular equivalents are discussed together with the bodies described by the former as cryohydrates and sub-cryohydrates. These, it was said, may be regarded as "very fusible definite crystalline compounds, containing many portions of water to a single portion of a salt or alkaloid." The author then proceeded to express his dissent from the view maintained by Guthrie that in these compounds the "constituents are not in the ratio of any simple multiple of their chemical equivalents," saying that their composition, as was already declared of similar cases in 1867, does not present "a deviation from the law of definite proportions," but "is only an expression of that law in a higher form."

It was further said, "Messrs. Tilden and Shenstone, in their studies of the great solubility in water of salts when near their melting-points, have described compounds which, unlike the cryohydrates, are homogeneous liquids, containing, in the case of somewhat fusible compounds, like silver nitrate and benzoic acid, very small proportions of water; from which the experimenters are led to conjecture for bodies an indefinite solubility in water under proper conditions of temperature and pressure.* It is, however, easy to understand from the high equivalent weights of such dense liquids (which from their viscosity are probably colloidal) that compounds with water may exist in which the proportion of the latter, though definite, is so small a fraction that it would be neglected in the ordinary processes of analysis. . . . These two cases of apparently homogeneous compounds,—on the one hand, liquids existing at high temperatures, with very small proportions, and, on the other, solids at low temperatures, with very large proportions of water,—are alike illustrations of the complex formulas and high equivalent weights which we have so long maintained."

In connection with the studies of Tilden and Shenstone, the writer had already elsewhere recalled† the fact of the existence of combined hydrogen in many ignited bodies at the atmospheric pressure. Such are the hydroxides of barium, sodium, and potassium, and certain vitreous borates of the latter metals, long since described by Laurent, which, at a red heat and in tranquil fusion, hold an amount of hydrogen equal to 1 2 and 1·3 hundredths of water. The presence of water in talc, and even in epidote, beryl, and euclase, is well known, while perlite and pitchstone are hydrous glasses differing from obsidian in containing three or four hundredths of water. All of these are examples of the stability at elevated temperatures of solid compounds in which water exists dissolved, that is to say, chemically combined. They differ in degree only from the hydroxide of magnesium, or from zeolites like laumontite, and salts like the efflorescent hydrated sodium carbonate and borate.

6. In the second edition of the "New Basis for Chemistry," in a supplementary chapter, the author has discussed at some length, among other topics, the question of the dense polymeric vapour into which chemically stable liquids are transformed under pressure above the critical point of vaporisation.‡ Therein, in §120, are considered the observations of Messrs. Hannay and Hogarth published in 1880, according to whom alcoholic solutions of potassium iodide, and of the cobaltous and ferric chlorides among others, pass integrally at temperatures somewhat above the critical point of pure alcohol into dense vapours, which, in the case of the chlorides named, retain their characteristic colours; while the absorption-spectrum of cobaltous chloride, as well as that of an alcoholic solution of chlorophyll, remain unchanged above the critical point. More than this, it was observed that the dense vapour of alcohol at 300° dissolved solid potassium iodide. The critical point of alcohol they found, as a mean of many experiments, to be 234·6°, with a pressure of 65 atmospheres, which agrees closely with the previous figures of Sajotschewsky, who found 234·3° at 62·1 atmospheres, while Ramsay and Young have more lately assigned 243° at a pressure of very nearly 63 atmospheres. Messrs. Hannay and Hogarth further observed that a saturated alcoholic solution of anhydrous calcium chloride separated at 230° into a lighter and a denser layer, which latter at 255° dissolved, but reappeared when the pressure was taken off. Regarding this they remark that "a com-

* *Philosophical Transactions*, 1884; Part I., pp. 23—36.

† Hunt, "Mineral Physiology and Physiography," pp. 219—222.

‡ That these dense vapours are to be regarded as polymers, or in other words, as resulting from the chemical or intrinsic condensation of the normal vapours, is apparent from the early observations of Cagniard de Latour himself. Andrews, moreover, found that carbon dioxide at 60·7°, under a pressure of 223 atmospheres, is reduced to 1·447, or less than one-half of the volume which should belong to the normal gas at this temperature and pressure, according to Boyle's law. The dense vapour of ethylic alcohol affords a more striking example of the same fact, since, according to Messrs. Ramsay and Young, a grm. of this liquid, which has at 4° a volume of 1·2403 c.c., acquires at the critical point a volume of about 3·5 c.c., so that the specific gravity of the vapour by their observation at 243° with a pressure of about 63 atmospheres, is nearly 0·28, water being 1·00. This corresponds to a four-fold intrinsic condensation, or to $4(C_2H_6O)$, since the normal vapour of alcohol, calculated for the above temperature and pressure, should, in obedience to the extrinsic influences of temperature and pressure, have a specific gravity of 0·0681, or one-fourth of the number observed.

bination of the chloride with part of the alcohol evidently occurs, and at a higher temperature diffusion takes place until the fluid is quite homogeneous." Similar phenomena were observed with the alcoholic solution of ferric chloride. These remarkable observations, which seem to show the integral volatilisation of solutions and their passage into dense polymeric vapours, as well as the solubility of solids in such vapours, and the separation of apparently homogeneous solutions at elevated temperatures under pressure into distinct layers of different densities, deserve more attention than they have yet received from chemists.*

7. Many points in the theory of solution are well illustrated by the example of sodium sulphate. This is found to be most soluble at 20°, when 100 parts of water dissolve 52·76 parts of the anhydrous salt, yielding a solution which possesses a certain degree of stability, and retains its liquid form at ordinary temperatures in closed vessels, but by agitation is readily changed in great part into crystals of the decahydrate, $Na_2SO_4.10H_2O$—having a specific gravity of 1·47 to 1·48—which contain for the 52·76 of sodium sulphate 66·80 parts of water, or more than two-thirds of the solvent liquid. This hydrate has its point of maximum solubility in water at 34°, while that for the anhydrous salt, as we have seen, is 20°. The crystallised decahydrate is slowly changed at 34° into a liquid, melting, as it is said, in its water of crystallisation. From this liquid, as from the original solution, by a reduction of temperature, or by contact with alcohol, crystals of a new compound, the heptahydrate,—

$$Na_2SO_4.7H_2O,$$

are deposited. These, which are much harder than the last, are very unstable, and, after removal from the liquid, become milk-white by a heat of 15°, or by contact with a foreign body, and are changed, with a considerable rise of temperature, into an admixture of the anhydrous and the decahydrated sulphate. This latter, in dry air at ordinary temperatures, loses its combined water, and passes into the anhydrous salt. A similar decomposition also takes place when a saturated solution of sodium sulphate is heated above 40°, crystals of the hard and very dense anhydrous salt—specific gravity 2·64 to 2·73—being deposited. These are more or less completely re-dissolved on cooling until the temperature reaches 18°, when the formation of crystals of the heptahydrate begins, and the previously separated anhydrous sulphate itself is gradually converted into the same hydrate. When a liquid containing an excess of crystals of the heptahydrate is heated to 27°, these melt, like those of the decahydrate, and the solution will then yield crystals of the anhydrous salt. From all these facts Löwel concluded, in 1856, that sodium sulphate exists in three distinct forms in aqueous solutions, namely, as a decahydrate, as a heptahydrate, and as the anhydrous salt.† The decahydrate is readily dissociated below 34° into heptahydrate and water, and above 34° into the anhydrous salt and water, while the unstable heptahydrate is itself readily transformed into an admixture of the anhydrous salt and the decahydrate. We may regard the various liquids obtained with sodium sulphate and water as liquid forms of the decahydrated, the heptahydrated, and the anhydrous sodium sulphate, intermingled with water, or at certain transition temperatures with each other. From such admixtures anyone of these sulphated species may not only separate, under slight provocation, in a crystalline form, but also under favourable conditions (which for obvious reasons are not easily attained in practice) in liquid form, under the influence of gravity, as already suggested. In this view of solution, there is not only in change of pressure (as long since shown by Sorby), but in change of temperature, in evaporation, in dilution, and in crystallisation, a constant making and unmaking of chemical species. In the mingling of liquids, wherever change of volume is apparent, chemical change is going on. When that ceases it may be assumed that admixture takes the place of solution.

8. According to the hypothesis regarding densities which the present writer has elsewhere maintained, volume is constant, and the integral or so-called molecular weight of the species varies, not only for gases and vapours, but for liquids and solids, as the specific gravity. This molecular weight is in fact the weight of any given volume of the species in question, whether solid, liquid, or gaseous, as compared with that of an equal volume of hydrogen gas at standard temperature and pressure, and may thus, with great propriety and significance, be called the equivalent weight of the species. Hydrogen gas being thus assumed as the unit of specific gravity for all species whatever, liquid water, the commonly received unit of specific gravity, which is formed by the intrinsic condensation or polymerisation of 1192 volumes of H_2O (=17·96) at standard temperature and pressure, has an integral weight of 21,408=1192 (H_2O), or in round numbers, 21,400. Comparing with this the hard and heavy anhydrous sodium sulphate (d=2·64—2·73), and the softer and much lighter decahydrate (d = 1·47—1·48), we have, with O=15·96, for the formula Na_2SO_4=141·84=p, and for $Na_2SO_4.10H_2O$=321·44=p. From these data we proceed, in accordance with our hypothesis, to fix the coefficient of condensation, or of polymerisation, of the two salts, and find for the first 400(Na_2SO_4)=57·780, which corresponds to a specific gravity of 2·65, and for the second, 98($Na_2SO_4.10H_2O$)=31,501, which gives a specific gravity of 1·472.*

* See Hannay and Hogarth, CHEMICAL NEWS, xli., p. 103, and *Proc. Roy. Soc.*, xxx., pp. 178, 484; also Ramsay, *Ibid.*, p. 324.

† For the data here employed the reader is referred to "Watts's Dictionary of Chemistry," *sub voce*, Sulphates of Sodium, and also to Löwel's papers in the *Ann. de Chimie et de Physique.*

* For a further discussion of the author's hypothesis regarding densities, see a paper entitled "Integral Weights in Chemistry," *L. E. and D. Philos. Mag.*, Oct., 1887; also "The Integral Weight of Water," *Ibid.*, April, 1888.

FURTHER NOTES ON DISSOCIATION BY CONTACT-ACTION.†

By the Rev. A. IRVING, D.Sc., B.A.,
Senior Science Master of Wellington College, Berks.

Two years ago, at the Birmingham meeting, I had the honour of reading a paper before this Section, in which I propounded and gave evidence for the theory which had been growing in my own mind for some years previous, as to the probable cause of the initiation of the action of gases upon one another in contact with heated and chemically inactive porous bodies, of which platinum-sponge and platinised asbestos may be considered the most familiar examples. I showed that in some cases the reaction was brought about by the contact of heated siliceous bodies, such as fragments of pumice previously cleaned by calcination. During the two years which have passed since, I have repeated most of the experiments referred to in that paper, and always with the same results. Dr. Hodgkinson, the Professor of Chemistry at the Royal Military Academy, has also described in the CHEMICAL NEWS, quite recently, a simple and effective modification of the experiment for exhibiting the combination of SO_2 and free O_2 in a lecture, which is very easily performed. I have done this with my own senior class, and it seems to me to bear testimony to the truth of the theoretical explanation which I ventured to put forward, from the circumstance that the experiment is so arranged that the platinum-sponge is heated outside the apparatus before the gases are brought into contact with it, plainly showing that the reaction is not due to condensation of the O_2 in the pores of the sponge previous to the heating.

Briefly stated, the theory regards the reactions (in all such cases of contact-action) as due to the increased "bombardment of the molecules" upon the solid, owing to the increase of the heated solid surface exposed,

† Read before the British Association, Bath Meeting, Section B.

added to the increased translational energy of the molecules themselves; the increased frequency of impact causing a rise of the atom-temperatures, and a corresponding increase in the intra-molecular work done (of all vibrational energy) in unit of time, as distinguished from inter-molecular or translational energy. Considering the great differences of thermal conditions in the individual molecules in any given mass of a gas, it is conceived that many of these molecules which exist for the time in a thermal condition considerably above the mean which is indicated by the thermometer, are already in such a state of intra-molecular vibrational energy that the accession of heat to them which the increased "bombardment," engenders is sufficient to cause dissociation in some cases; and this was suggested as a probable explanation of the phenomena known as the "intial temperature of dissociation," and the apparent lowering of that initial temperature by contact action. In the case of a mixture of gases, such as SO_2+O_2, or NH_3+O_2, or $NO+H_2$, it seems probable that the conditions required to bring about a transfer of atoms might be realised short of actual dissociation of any of the molecules, the increase of the atomic vibrational energy required being merely such as to so far weaken the bond which holds them together in the original molecule, that this weakened bond of affinity might be overcome by the counter-attraction of other loosely-held atoms of opposite electro-chemical energy. For such a condition of things the term "quasi-nascent state" was proposed. The paper was published in full in the Chemical News, and was criticised in the pages of the same periodical. My reply to those criticisms brought a private letter from the author of them, confessing that he had misunderstood the argument of my paper, and apologising for his hasty criticism, which, he said, was based on an insufficient study of it. This is the only criticism which I have met with since the paper was read; but I may say that the ideas thrown out by Prof. Williamson in his farewell address at University College seemed to me to give considerable support to the view which I have ventured to put forward.

In my work on "Rock-metamorphism," which is now in the press, I have been led to consider the possible genesis of the great crystalline series of archæan rocks (the granitoid rocks, the gneisses, and the crystalline schists), which together make up the primordial lithosphere of the earth. In any such account as it is possible to give of their origin, on the assumption (which all the known facts seem to warrant) that the earth was once a glowing mass, it became necessary — on rejecting the fanciful notion that these primitive crystalline rocks are the results of later "regional metamorphism"—to account for the origin of the graphite in them, which geological writers have, in this country, without exception, so far as I know, assumed to be a product of extreme carbonisation of organic matter of vegetable origin; an assumption which has been one of the main props of the notion as to the origin of the primitive crystalline rocks referred to above. Now carbon (even graphitic carbon) is known to occur in meteorites, and the spectroscope has revealed the existence of hydrocarbons in the heads of comets. It is but the wildest fancy to attempt to ascribe the origin of such carbon to the carbonisation of organic matter. Reflecting upon such facts as these, and upon others well known to the chemist, as to the synthetic formation of such hydrocarbons as acetylene marsh-gas, and some others of a more complex nature through the agency of metallo-carbides, one was soon led to see that at a certain stage of the earth's development a good deal of the carbon of the original nebulous matter of the earth might easily have got hold of some of the hydrogen.

Now we know very well that some hydrocarbons can be dissociated by pure heat at the high temperature of the electric spark; and we know also that hot alkali metals, and even the glowing metal of the magnesium flame, can reduce CO_2 to elementary carbon in a very pure form; also that the most refractory hydrocarbons can be reduced to elementary carbon by the action of dry chlorine gas upon them at red heat. It is possible that some of the graphite in the primitive archæan rocks may have been produced by any or all of these agencies. But when we note the way in which graphite occurs, often in considerable seams in those gneisses and schists, we are compelled to look about for some other cause more extensive in its operation.

The deposit of elementary carbon in the interior of the roofs of the fire-clay retorts of our gas-works is probably to be referred to the contact action of the heated porous surface of the retort upon the heavy hydrocarbons of the crude coal-gas; at least this seemed a fair deduction from the theory which I had ventured to put forward two years ago. Last May I subjected this view to the test of experiment. An ordinary combustion-tube about 9 inches long was drawn out at one end so that a continuous small flame of coal-gas could burn at it. This tube was packed with pumice fragments, which had been well-calcined just before. The tube was then attached in the ordinary way by flexible tubing to the gas-pipe. The coal-gas was passed and lighted at the small end. The tube was then slowly heated by a wide Bunsen-flame. As the temperature rose to a dull red heat, dissociation of the hydrocarbons set in rapidly, and the pumice-fragments soon became coated over with a steel-grey film of elementary carbon. The tube was then detached, and after being allowed to cool while closed up it was attached to an oxygen holder, with the intervention of calcium chloride, strong sulphuric acid, and potash, to remove moisture and traces of CO_2. The oxygen was passed for several minutes through the tube, and into lime-water, without any visible result. A small zone of the tube was then heated in a spirit-flame, and as soon as this zone was heated to a dull redness, a copious precipitation of $CaCO_3$ in the lime-water took place, the fragments of pumice in the heated zone being soon cleaned to their pristine whiteness.

The theory of dissociation by the contact-action of heated solids thus receives *visible demonstration in the case of hydrocarbons.* To apply this to the genesis of graphite in the primitive rocks, we have only substituted for the heated pumice-fragments in our experiment the glowing slaggy portions of the earliest crust which floated in the magma (real pumice-fragments on a grand scale); and, admitting the co-existence of hydrocarbons in the gaseous envelope which then surrounded the globe, recollecting also that the crystalline form ascribed to graphite in our text-books rarely (if ever) occurs in native graphite, we have a complete explanation of the origin of graphite in the primitive crystalline rocks without any intervention whatever of organic matter.

I have since repeated the experiment with a tube about 5 feet long, and have deposited amorphous carbon through the whole length of the tube upon the pumice, which was gradually heated from one end to the other. In a third trial the tube was heated in a gas-combustion furnace to the temperature of incipient fusion of the Bohemian glass, and the deposit was more copious than ever; but the carbon had upon the whole a more sooty appearance. This agrees with some results lately obtained by the Hon. Charles A. Parsons in some experiments on carbon at high temperatures and under great pressures, of which he gave an account in a paper read before the Royal Society in June last. Mr. Parsons informs me that he has found that the higher the temperature the softer the graphite produced, and that regardless of pressure. His experiments, however, had nothing to do with dissociation by contact action, since he started with his carbon in the elementary state.

In the second of the experiments which I have mentioned above, an accessory result was observed. As the tube was gradually heated towards the flame end, a yellowish deposit was observed in front of the flame which was applied to heat the tube. After the experiment was complete this was distilled into the drawn-out portion

of the tube, which was then cut off. On examination it was shown to be elementary sulphur by burning with a flash of blue flame, and with the smell and acid reaction of SO_2; while another portion of it was washed out in CS_2, and crystallised out in the usual rhomboidral forms, as the solvent was allowed to evaporate away on a watch-glass. We have thus evidence of dissociation by contact-action of heated solids, not only of the hydrocarbons, but also of the sulphur compounds present in coal-gas.

I am of course not prepared to say that some portions of the black sooty deposit may not consist of heavy refractory hydrocarbons, as, owing to the pressure of other subjects that have engaged my attention lately, I have not made a complete combustion analysis of it, so as to determine its composition quantitatively. But even if some are present, this would not vitiate the application which I have proposed, of the theory of dissociation by contact-action to the genesis of graphite, seeing that well authenticated analyses are on record of a certain percentage of volatile hydrogenous matter in native graphite. Roth* (*e.g.*) records a case in which as much as 1·34 per cent of hydrogen was found by Cloës in a specimen of very pure Canadian graphite, and another case in which Méne found as much as 7·30 per cent of volatile matter in graphite from Passaw.

THE SOLUBILITY OF BARIUM SULPHITE IN HYDROCHLORIC ACID.

By G. STILLINGFLEET JOHNSON.

In a "Note on Barium Sulphite," published in the Chemical News, vol. lviii., p. 128, Mr. E. Rattenbury Hodges concludes that barium sulphite is not soluble in hydrochloric acid. His experimental evidence of this insolubility is, that when sulphur dioxide gas is passed into a solution of barium chloride, a precipitate is obtained which is insoluble in hydrochloric acid.

Three experiments described below throw further light upon the subject:—

I. A clear solution of barium hydrate (baryta water) is boiled to expel dissolved oxygen, and sulphur dioxide gas (obtained by the action of hydrochloric acid upon sodium sulphite) is passed into the solution. A copious precipitate results. On adding a few drops of hydrochloric acid, free from H_2SO_4 and HNO_3, this precipitate is at once and completely dissolved.

II. A solution of barium chloride is boiled, to expel dissolved oxygen, and pure sulphur dioxide gas is passed into the solution. No precipitate is formed, or only a faint opalescence, which is not dissolved by hydrochloric acid. *Prolonged* boiling is necessary to ensure complete absence of precipitate, but saturation with the gas produces no turbidity if this precaution has been taken.

III. A solution of barium chloride, made with unboiled water, is saturated with sulphur dioxide gas. A precipitate is produced, which is quite insoluble in hydrochloric acid.

The conclusions drawn from the above experiments are as follows:—

I. Pure barium sulphite is readily and completely dissolved by hydrochloric acid.

II. Pure barium chloride in aqueous solution is not precipitated by pure sulphur dioxide gas.

III. Barium chloride in aqueous solution is precipitated by sulphur dioxide in presence of dissolved oxygen, the precipitate being barium sulphate, not barium sulphite.

$$BaSO_3 + O = BaSO_4.$$

It will be remembered that oxygen converts 13½ times its weight of barium sulphite into barium sulphate.

King's College, London,
Sept. 15, 1888.

* "Allgem. u. Chem. Geol.," Bd. 1, p. 37.

NOTE ON A TEST FOR SACCHARINE.

By DAVID LINDO.

In the Chemical News (vol. lviii., p. 51) the author published a test for Fahlberg's saccharine, which he has since found can be modified to advantage as follows. After placing the saccharine with concentrated nitric acid in a small porcelain dish, evaporate to dryness on the water-bath, or by moving the flame of a spirit-lamp to and fro under the dish, blowing on the surface occasionally to facilitate evaporation, and taking care the heat does not rise too high. If the dish is allowed to cool and a few drops of strong solution of potash in 50 per cent alcohol are added to the residue, a faint yellow colour only will be developed. Spread the liquid over the surface of the dish, and before it has settled to the bottom, apply heat with the lamp, as above, quickly all over the under surface of the dish. If the vapour of alcohol happens to ignite it must at once be extinguished. A greater variety of colours will be developed in this way than by following the directions formerly given. As the dish cools and moisture is absorbed the colours fade; by heating they can be reproduced, but not in the same perfection as at first.

Falmouth, Jamaica, B.W.I.,
August 27, 1888.

NOTE ON THE DECOMPOSITION OF NITRIC OXIDE IN CONTACT WITH WATER AND ALKALINE SOLUTIONS.

By STEPHEN COOKE, F.C.S.

Priestly, in his "Experiments on Nitric Oxide," says:—"Being desirous of ascertaining whether nitrous air tended in any degree to a spontaneous decomposition by long standing only, without being in contact with any substance that could be supposed to have an affinity with any constituent part of it, I filled a large phial and corked it very tight, keeping it for the most part with its mouth immersed in a vessel of water, but neglected it and suffered the water to evaporate. However, examining the air about two years afterwards, I found it to have the same power of diminishing common air that freshly-made nitric oxide has." He, however, almost immediately afterwards mentions other experiments in which the nitric oxide appears to have undergone a change on standing a long time; but as he gives oxygen as one of the products formed, there seems to be some mistake in the experiments.

Humboldt and others declared that nitric oxide is decomposed by contact with water, with the formation of nitrate of ammonium.

Davy, however, rejects these experiments, and comes to the following conclusions as the results of his experiments:—"(1) That nitric oxide is not decomposable by water; (2) That the diminution of volume of nitrous gas placed in contact with water is owing to a simple solution of it in that fluid."

Russell and Lapraik (*Jour. Chem. Soc.*, xxiv., 37, 1876) have shown that water and nitric oxide kept at 100° C. for a fortnight, and then for four months at the ordinary temperature, had undergone a contraction of 46·7 per cent.

After making some of my experiments on nitric oxide and hydrogen in presence of platinum, an experiment was tried with the gases alone (*i.e.*, without the platinum), with the result that there was a slow but gradual contraction. On examination of the residual gases, after standing for more than twelve months, it was found that the hydrogen had no part in the reaction (except retarding it); but the nitric oxide had undergone partial decom-

position into HNO_2 and nitrogen, together with a little nitrous oxide.

Two tubes, about 0·8 metre long, were filled, one with two volumes of nitric oxide and one volume of hydrogen, the other with equal volumes of the two gases. After standing fifty-four weeks, the first had undergone a contraction of 230 m.m.; and on adding ferrous sulphate, there was a further contraction of 260 m.m., leaving 43 m.m. of nitrogen and nitrous oxide, the hydrogen being left unchanged. The liquid in the tube was strongly acid, and gave the reactions for nitrous acid. In the tube containing the larger proportion of hydrogen only 150 m.m. of gas had disappeared in the same time.

From these experiments it is evident that nitric oxide undergoes a change by merely standing in contact with water. Since these experiments were made the subject has been a little more fully investigated; tubes with platinum were used in some cases, and in others nitric oxide stood over water in tubes without any platinum.

The tubes used were about 400 m.m. long. Pure nitric oxide was used. The tubes when filled were kept standing over pure water, or in some cases over mercury with 20 or 30 m.m. of water at the top. They were kept in the dark and at the ordinary temperature.

With tubes containing platinum the contraction was gradual but slow, and for the first three or four weeks amounted to 50 m.m. per week. After about one-half has disappeared the action gets slower, and in tubes of this kind is not complete for nearly three months. The total contraction will be at least 90 per cent of the original gas. The residue is chiefly nitrogen, but it also contains a small quantity of nitrous oxide, and a portion of this gas is also found in solution. The water is acid and contains HNO_2.

In a tube similar to the last, but containing no platinum, the action is slower—in the first month the contraction was 100 m.m., and towards the end the action is very slow indeed. In nine months the change was complete, the gas remaining being from 10 per cent to 20 per cent of the original; the nitric oxide had quite disappeared, the residue consisting of nitrogen and nitrous oxide.

In a tube containing platinum the action of heat in accelerating the change was tried. Nitric oxide was sealed up in such a tube with a little water and kept for two hours at 100° C.; there was a contraction of 20 per cent, the residue consisting of nitric oxide, nitrous oxide, and nitrogen.

It is well known that a solution of caustic potash acts gradually on nitric oxide, potassium nitrate and nitrous oxide resulting from the change. The action, however, is very slow, taking some months to complete. Russell and Lapraik have shown that the action is much accelerated by keeping at a boiling temperature. At common temperature, or at 100° C., the action is much hastened by the presence of platinum. A tube of nitric oxide 400 m.m. long, containing platinum, was placed in a solution of caustic potash; the action was complete in three weeks, about three-fourths of the original gas disappearing. In a similar tube, sealed up and kept for three hours at 100° C., a like change took place.—*Glasgow Philosophical Transactions.*

THE INFLUENCE OF MANGANOUS SULPHATE AND OTHER SALTS ON THE TITRATION OF IRON IN HYDROCHLORIC ACID SOLUTION BY POTASSIUM PERMANGANATE.

By DAVID L. LUKE.

The author has made a series of experiments similar to those performed by the late Dr. Clemens Zimmermann, Kessler, Thomas, and others, studying the influence of manganous sulphate and other salts on the titration of iron in hydrochloric acid solution with potassium permanganate. His results were mainly corroborative of what these investigators have already shown.

It was found that the presence of manganous sulphate in the hydrochloric acid solution of the ferrous salt would prevent, for a short while at least, the reduction of a greater amount of potassium permanganate than corresponds to the amount of ferrous salt in solution, and also that no free chlorine was detected on titration. Lead chloride acted in a manner similar to manganous sulphate.

Magnesium, cobalt, and copper sulphates were also tried, but gave no good results, showing them to be of no value.

A very important precaution is to watch the end reaction in the hydrochloric acid solution containing $MnSO_4$ very closely, which can be distinguished by the first complete colouration throughout the liquid. If not stopped there too much permanganate can be easily added, because of the almost immediate fading out of the colour of the first few c.c. added after the end reaction was reached.

The solutions used were similar to those of Zimmermann. Hydrochloric acid = 1·12 sp. gr., H_2SO_4 = 1·84 sp. gr., a dilute solution of permanganate, with a titre of 0·0039603 Fe, and a stronger one of 0·0081136 Fe. Manganous sulphate solution 200 grms. in 1 litre. Also a hot saturated solution of lead chloride.

(1). The first experiments were with ferrous ammonium sulphate, and gave the following results:—

No.	$Fe(NH_4)_2(SO_4)_2 + 6H_2O$. Grm.	H_2SO_4. C.c.	HCl. C.c.	$MnSO_4$. C.c.	$K_2Mn_2O_8$. C.c.
1.	0·7	15	—	—	25·10
2.	0·7	—	10	—	25·65
3.	0·7	—	10	20	25·10
4.	0·7	—	20	—	25·75
5.	0·7	—	20	20	25·10
6.	0·7	—	40	20	25·20
7.	0·7	15	20	—	25·50
8.	0·7	15	20	20	25·20
9.	0·7	15	—	20	25·20
10.	0·7	15	—	—	25·20

The next experiments were made by fusing magnetite with potassium bisulphate, dissolving in water, reducing with zinc, and titrating with the strong solution of permanganate.

No.	Iron Solution. C.c.	HCl. C.c.	$MnSO_4$. C.c.	$K_2Mn_2O_8$. C.c.
1.	100	—	—	37·75
2.	100	20	—	38·00
3.	100	20	20	37·80
4.	100	40	—	38·05
5.	100	40	20	37·80

A similar hydrochloric acid solution of magnetite was made, reduced with zinc, and titrated with the same permanganate solution.

No.	Iron Solution. C.c.	H_2SO_4. C.c.	$MnSO_4$. C.c.	$K_2Mn_2O_8$. C.c.
1.	50	—	—	38·00
2.	50	10	20	37·50
3.	50	10	20	37·50
4.	50	10	20	37·45

A ferro-manganese dissolved in hydrochloric acid and titrated twice in presence and twice in absence of manganous sulphate, gave each time the same result on titrating. It should be said that the ferro-manganese contained about 65 per cent manganese and 30·4 per cent iron.

N. Wiley Thomas's method consists in substituting lead chloride for manganous sulphate, and proceeding as before. A quantity of magnetite was therefore dissolved by the author in hydrochloric acid, and titrations were made in presence of lead chloride, also manganous sul-

phate, and alone. The lead chloride was added as a hot saturated solution.

No.	Iron Solution. C.c.	$PbCl_2$ C.c.	$MnSO_4$. C.c.	$K_2Mn_2O_8$. C.c.
1.	25	—	—	16·00
2.	25	20	—	15·60
3.	25	30	—	15·60
4.	25	20	—	15·60
5.	25	—	20	15·60
6.	25	—	20	15·55

From the above results it will be observed that under the proper conditions, *i.e.*, in presence of either manganous sulphate or lead chloride, Margueritte's method for the titration of iron will work in hydrochloric acid solution as well as in sulphuric acid.—*Journal of Analytical Chemistry*, Vol i., Part 3.

REPORT OF THE COMMITTEE*

APPOINTED FOR THE PURPOSE OF INQUIRING INTO AND REPORTING ON

THE PRESENT METHODS OF TEACHING CHEMISTRY.†

The Committee decided at first to restrict its enquiries to the teaching of chemistry in schools. With this object, in December last they addressed the following letter to the Head Masters of Schools and the Principals of Training Colleges, both in Great Britain and Ireland, in which chemistry forms a part of the curriculum. The list of these schools was compiled from the "Educational Year-Book."

Committee on Chemical Teaching.

Dear Sir,—At the meeting of the British Association held at Manchester in September last, Professor H. E. Armstrong, F.R.S., Mr. J. T. Dunn, Professor W. R. Dunstan, Dr. J. H. Gladstone, F.R.S., Mr. A. G. Vernon Harcourt, F.R.S., Mr. Francis Jones, Professor McLeod, F.R.S., Professor Meldola, F.R.S., Mr. Pattison Muir, Dr. W. J. Russell, F.R.S., Professor Smithells, Mr. W. A. Shenstone, and Mr. Stallard were appointed as a Committee for the purpose of inquiring into, and reporting on, the present methods of teaching chemistry.

It is felt that great difficulty exists at the present time in teaching chemistry to elementary students, owing chiefly to the absence of agreement among teachers as to the best modes of giving instruction and to the diverse views of examiners. It is hoped that an inquiry by this Committee will be valuable not only to teachers of elementary chemistry, but also to those who have the responsibility of examining in this subject. The members of the Committee venture, therefore, to hope that you will assist them by furnishing, at as early a date as possible, such a report on the chemical teaching in your school as you consider will be most likely to aid their inquiry, more particularly with regard to the following points:—

1. The objects with which chemistry should be taught in schools.
2. The difficulties that are met with in teaching, and the best way of obviating them; the influence exerted by external examiners on the character of the teaching.
3. The methods which, in your opinion, are most likely to render the teaching effective as a mental discipline, and as a preparation for subsequent instruction in the higher branches of the science or in applied chemistry.

The Committee will also be greatly obliged for information on any other points directly connected with the teaching of elementary chemistry; any data with which you may favour them will be regarded as confidential, and nothing of a personal nature will be published without your previous consent.

In making any communications to the Committee, it will be convenient if you will kindly affix to the manuscript the paper which is enclosed.

I am, Sir,
Your obedient Servant,
Wyndham R. Dunstan,
Honorary Secretary to the Committee.

Five hundred copies of this letter were circulated, but only eighty-six more or less extended replies have been received; they include the majority of the largest public schools in Great Britain. These replies have been the subject of careful consideration by the Committee.

The schools which have reported represent a total number of 23,350 boys, and of these 8,418 receive instruction in chemistry; that is, 36 per cent. It will be useful to summarise in this Report, by means of extracts from typical replies, the chief points of general interest which have been alluded to, particularly those that were raised by the three questions suggested by the Committee in their letter.

1. *The Objects with which Chemistry should be Taught in Schools.*

There is almost unanimous agreement as to the high educational values of the science of chemistry. Teachers seem agreed that chemistry should be taught in schools with two objects: first, and mainly, on account of the mental training and intellectual discipline it affords; and secondly, for the sake of its applications in the different professions and trades which the boys may subsequently follow and also in its direct bearing on the facts of everyday life. This view of the importance of chemistry as a part of the school curriculum is well exemplified by the following extracts taken from the reports made by various schools, both large and small, and representing boys who afterwards follow a diversity of trades and professions.

I. "Chemistry should be taught in schools—(1) As an educational subject or mental discipline. In studying chemistry the pupils are led to cultivate habits of *observation*, because the statements made in chemistry are based on facts actually seen; or *reflection*, because the accurate statement of even the simplest observed fact requires not a little reflection; and of *reasoning*, because reasoning is required before one can decide that any one particular result in an experiment is due to some one particular antecedent circumstance out of several. Chemistry also is especially the science in which experiment can be most readily had recourse to by the pupil. (2) As a valuable branch of instruction. Supposing that the mental powers were not developed and strengthened by the study of chemistry, it might still be desirable that pupils should not leave our public schools wholly ignorant of the composition, properties, and uses of the materials of everyday life."

II. "Science and history alone of the subjects taught in schools perform a twofold function. They give connection of ideas, logical power, and education in the fullest sense, while at the same time they store the mine with useful facts likely to make the possessor a more valuable member of the body politic. Hence chemistry may be taught to *all* boys just in the same way as ancient languages and higher mathematics, without any thought of the future career of the pupil, or whether chemical knowledge is likely to be of practical use to him or not. In this way the practical demonstration of chemical facts becomes a great object-lesson, while chemical theory becomes an introduction to logic. Chemistry may be taught for other reasons:—(i.) To enable boys who show no special aptitude for any other subject to obtain a scholar-

* Consisting of Prof. H. E. Armstrong, Mr. J. T. Dunn, Prof. W. R. Dunstan (Secretary), Dr. J. H. Gladstone, Mr. A. G. Vernon Harcourt, Mr. Francis Jones. Prof. H. McLeod, Prof. Meldola, Mr. Pattison Muir, Dr. W. J. Russell, Mr. W. A. Shenstone, Prof. Smithells, and Mr. Stallard. Drawn up by Prof. Dunstan.

† Read at the British Association, Bath Meeting, Section B.

ship and university education. (ii.) As a special subject, likely to be useful for those who, having passed the preliminary arts' examination, intend to adopt a medical career."

III. "The objects with which chemistry should be taught in schools:—1st. To make lads take a keener interest in natural phenomena. A few well-chosen experiments will excite their wonder, and at the same time create an interest in the secrets of nature. 2nd. To teach lads to see, *i.e.*, to develope their powers of observation. 3rd. To impress upon lads that there is a definite law of order in nature. Lads soon see that from the same bodies under similar couditions certain fixed results must follow. 4th. To make boys logical and not too hasty in generalisation from a few isolated observations. Chemistry is peculiarly well fitted for this purpose. 5th. To direct the powers of destructiveness and constructiveness which are always so pronounced in boys, since they soon learn to be interested in simplifying many complex forms and in building up others. 6th. To impress upon lads, as soon as possible, that everyday life must necessarily be influenced beneficially by a knowledge of the chemical properties of a very few simple bodies and the laws which determine their mutual interaction."

IV. "There are, I think, two considerations to be kept in view:—(α) the general educational value of the work which gives chemistry a claim to be considered a necessary part of any liberal education, whatever be the profession in view; (β) the necessity of teaching chemistry on such lines that the instruction given may be a sound and valuable apprenticeship for such boys as may be led to devote themselves specially to this subject in the future."

The following sentences (V.) were written by the headmaster of one of the first public schools in England:—

V. "I think that the objects with which chemistry should be taught in schools are three:—(α) to make every boy acquainted with common scientific facts, useful to him in every branch of life. (β) To give opportunity to boys with special aptitude for science to take up and develope the study; many a boy who seems dull at languages brightens over science. (γ) To enlarge the mind by the suggestion of new methods and processes and by the illustration of the mode in which nature works."

VI. "I have found that the teaching of chemistry, besides its direct value for professional and business purposes, is of great importance as a means of developing the minds of boys who have no aptitude for other subjects. I have found that many boys who cannot get on at classics and mathematics take an interest in and learn chemistry, thus being greatly encouraged in their other work by the knowledge that there is something that they can do."

VII. "Chemistry should be taught chiefly for mental discipline. Practical chemistry is almost the only school subject in which hands and brains are equally employed."

VIII. "In schools chemistry, like other subjects, is, no doubt, taught with a double view—mental training and the imparting of valuable knowledge. As to the former of these, the subject is not, in the opinion of the present writer, of great value, for the methods of demonstration as they can be exhibited in a school laboratory are not very rigorous and logical, and at the best seem rather to afford a strong presumption than a satisfactory assurance in favour of any particular conclusion. As to the latter object, it may be said that it is not one about which educationists generally are very enthusiastic. At the same time, if there is any subject more than another the knowledge of which is desirable it is chemistry. The entire change of mental attitude towards physical surroundings, which even the slightest knowledge of the principles of chemistry induces, is most noticeable, and boys find it both a source of healthy wonder and, though they do not observe it themselves, a great mental stimulus. There is, of course, one other object with which chemistry may be taught, namely, for the sake of those who will find it directly useful in after life. But as they are, after all, only a small percentage of the whole, the argument of practical utility is one which cannot be advanced as in itself a justification for teaching the subject."

IX. "Chemistry should be taught in schools while boys are comparatively young, in order that those who have no taste for classics may find some work in which they can take a practical interest. There are boys who, without being stupid, have no taste whatever for books, and the chance of practical work, like chemistry, for which they can see some use of an obvious kind, may prevent many a boy from becoming a confirmed idler. The study of chemistry, therefore, should be encouraged as a distinct benefit to the character of many boys. It should also be encouraged for the public good, because any boy so interested in early life may be led to devote his after years to the pursuit of scientific subjects. And again, it should be taught in schools to enable boys who go into business now very young to have some slight knowledge of scientific facts of an elementary kind while they still have time to learn."

X. "All my experience shows that even to young children chemistry may be made the threshold of the fairyland of science, and that by means of it they may early acquire a profound sense of the rigorous, unyielding nature of law and of the unity in the midst of diversity which pervades the world around us. Again, as a mere discipline for the intellect, I believe chemistry is destined to take the place of Latin and Greek grammar, when a definite course of teaching has been laid down, and teachers have themselves mastered that course as thoroughly as former teachers had mastered their accidence and syntax. To make the pupil aware of the existence of an unknown, unexplained, inscrutable side to every and even the simplest phenomenon, is to awaken desire, expectation, pleasure—all the antecedents of healthy mental effort, and the difference between the daily, hourly life of one who has thus become conscious of the literally infinite, ineffable nature of things around him, and that of one who thinks he knows all about them, is immense."

XI. "Too much weight may easily be attached to the objection often urged against chemical teaching (and, indeed, against the study of other branches of natural science), that it fails to cultivate good taste and good style; that the learner is brought into contact merely with material facts and not with human thoughts, and so acquires a character and mode of expressing himself as hard, rough, and unsympathising as the laws of nature with which he deals. It is certainly impossible to avoid noticing that the abstracts of lectures and answers to examination papers shown up by those who have been, or are being, well trained in "the humanities" are composed in much better style than the productions of boys who have had less advantages of the kind, or who, from their dulness in other subjects, are considered to be exactly fitted for learning natural science. But the power of refuting this objection rests with the teacher. If he refuses to pass over bad spelling and bad grammar, if he takes the trouble not merely to point out slovenliness of expression, but to show how it may be corrected, and if the learner is compelled to re-write any careless, inaccurate work in better form, there seems no reason why an account of the two oxides of carbon, including an intelligent comparison of their properties, may not be made as good an exercise in English composition as an essay on points of Greek and Roman history."

2. *The Difficulties that are Met with in Teaching, and the Best Way of Obviating them; the Influence Exerted by External Examiners on the Character of the Teaching.*

Much might be written about the various difficulties which are alluded to in these reports in answer to the second question suggested by the letter of the Committee. The chief difficulties are stated to be those which arise from:—(i.) Defective organisation and considerations of expense; (ii.) the lower value attached to chemistry, as

compared with other subjects of the school curriculum; (iii.) the time which is devoted to the subject; (iv.) preparation for various examinations; (v.) absence of good text-books; (vi.) dearth of properly qualified teachers.

(i.) The expenses incidental to chemical teaching and the defective organisation, which is often the result of insufficient endowment, are the subjects of general complaint. Sometimes no laboratory is provided; frequently the laboratory accommodation is inadequate; and it appears that the details of the preparations for lectures and practical work generally devolve on the teacher himself. The following statements may be quoted. The first two are from the reports of small schools.

XII. "We have no laboratory or other facilities for practical work, and so our experiments have to be very simple and our work very elementary."

XIII. "The chemical teaching is quite elementary, and there is no apparatus, so that it is only taken as a lesson with figures drawn and explained on the blackboard."

XIV. "Thus our difficulties are:—(*a*) Having too many to teach. I am responsible for about 160 boys, and have no help. (*b*) The want of a large laboratory. We have a small but very good laboratory. There is, however, only accommodation for 12 boys, while I always have about 70 doing practical chemistry in an aggregate of six hours a week. Hence each boy gets only one hour a week. (*c*) The want of sufficient time to prepare for experimental work. The whole of my school time, except three hours, is taken up in teaching, so that all preparation has to be done either before or afterwards, the practical result being that I am obliged to limit my experimental teaching to the two lowest and the highest forms."

XV. "The chief obstacle to the effective teaching of chemistry here is the poorness of the laboratory—a room in the basement, low pitched, ill lighted, and worse ventilated, accommodating only 15 boys, and in such connection with the other class-rooms as to make some of them almost unbearable when experiments are made with any foul-smelling gas." (This school contains 500 boys.)

XVI. "To lecture properly, a master must have an assistant for the experiments. I do not know what is the rule; I hope I am an exception, for I am without one. I make use of one of the promising boys to help in the preparation preceding a lecture. This is not sufficient. A master cannot easily conduct his experiments, keep order, and carry on a judicious questioning and explanation at the same time.

XVII. "Every teacher of chemistry who has several lectures to deliver in the course of the week ought to have the services of a fairly intelligent assistant, who can get ready most of the experiments for him, or he ought to have extra time allowed him to do this himself. Of course it is possible to utilise the services of the more advanced pupils for the purpose, but this does not effect so much saving of time as might be thought, owing to the want of experience on the part of the boys, who in many cases require so much supervision that it is shorter for the teacher to do the work himself."

XVIII. "We have just abandoned the subject, owing to its ruinous expense if taught thoroughly."

XIX. "We have no laboratory, and have to do the best we can with a table in a class-room. Experiments are shown, but not performed by the boys for this reason."

XX. "Schools are often badly equipped with a suitable lecture-room, laboratory, and apparatus, partly from poverty, and partly sometimes from inability on the part of the head-master or governing body to appreciate the needs of the subject."

XXI. "Another difficulty is that in many cases the teacher has not time to prepare adequate experimental illustration. Until recently the chemical teaching in this school was done by the second master, who had the whole of the school hours not engaged in teaching science occupied in his own form in general subjects. A public day-school does not usually (like a science college) possess paid demonstrators and assistants; hence, unless the teacher has a considerable amount of time not actually occupied in teaching, it is impossible for him to make and set up apparatus for experiments in a proper manner, and experiments that constantly fail are worse than none."

(ii.) The following statements deal with the difficulties that ensue from the relatively low place which is generally afforded to chemistry in the school curriculum, and the low value which is assigned to it in public examinations as compared with the value attached to other subjects. This, it is said, often leads to the restriction of chemical teaching to inferior boys, some of whom may have failed in classics and other subjects. The best boys may leave the school, having received little or no instruction in chemistry.

XXII. "One difficulty arises from the low standard of public opinion as regards science. This is chiefly due to the extraordinary and utterly unaccountable view (confined, I think, to England and America) which classical men have always had of scientific studies. In this school, owing to the exceptional liberal-mindedness of the powers that be, this evil is unknown, but in other schools where I have taught the jealousy between those who represented different kinds of study was enormous, and clever boys were therefore more attracted to literature than to science."

XXIII. "As regards the difficulties in teaching chemistry, I think perhaps the first is non-classification. The boys are sent to chemistry lectures grouped according to classics; the result is confusion. Take the fifth form for example. It is sent into the laboratory for an hour's lecture. In that form you have some of your promising boys, also some of the weak ones, very good classics possibly, whom to teach chemistry is, you know, hopeless. But the work must be done, so you take a medium course, pitching your discourse to suit the average boy; you must be very careful to aim low, or you will certainly hit nothing. In doing this your lecture is below the promising boys, who feel a growing contempt for you or your subject, and at the same time the lowest boys are wearied by matter which they cannot grasp."

XXIV. "Two difficulties are:—(i.) Want of sympathy with natural knowledge on the part of the majority of university men who take to school work; (ii.) strong adverse traditions in many schools, backed up by the fashionable superstition that literary rather than scientific studies constitute the education of a gentleman."

XXV. "The difficulty is that parents do not yet recognise chemistry as a 'paying' subject, consequently their boys neglect it."

XXVI. "A serious difficulty is caused by the fact that boys may join a class in any term. This may not be a great evil in the case of languages or mathematics, but where from the very nature of the subject it is necessary, in order to understand and benefit by a lesson, that the preceding lesson should be first mastered, the case is altogether different, and it is not clear how this and the kindred difficulty of grouping in one set boys of very unequal powers and attainments can be obviated, seeing that schools are classified on other lines, generally according to proficiency in classics."

XXVII. "I believe that one of the great stumbling-blocks in the way of chemical teaching in day-schools is, that boys are often sent to the science master in classes determined by their position in classics or English subjects, so that there is no proper gradation in the teaching. This obtained here until recently, but now, by simultaneous teaching by three masters on two afternoons a week, it is possible to group the boys in the senior school according to their proficiency in science (mainly chemistry) alone. The result has been a considerable improvement in the quality of the work."

XXVIII. "The scholastic disrepute in which chemistry is held is apt to lead a head-master to devote to it the

least mentally qualified boys, who have absolutely failed on the classical side."

(iii.) It appears that the time which is usually allotted to chemistry in schools is altogether inadequate, and frequently this defect seems to constitute one of the teacher's greatest difficulties.

XXIX. "I suppose few grammar schools give more time to chemistry than four hours a week, and so long as competitive examinations assess chemistry at one-quarter the value of mathematics, and one-eighth that of classics, more time cannot be expected. When it comes to be recognised that the mind which is scientifically trained is most likely to produce work valuable to the community, and at the same time is best suited to grapple with the practical problems of everyday life, all this will be changed."

XXX. "This school contains 500 boys. The average number of those who receive instruction in chemistry is 30, and the time allotted to the subject is three hours a week."

XXXI. "The difficulty is to make all pupils take a real interest in the work; in the short time which is allowed to the subject it is apt to become a mere collection of facts in the boy's mind. It is a curious fact that a double labour is expected from the teacher of science, namely, a general development and quickening of the reasoning faculties, and the teaching of examination-chemistry at the same time; and all this has to be done in two hours a week! Parents at any rate tacitly pay a very high compliment to the resources of science when they expect this. As a matter of fact, the unfortunate science master very naturally leaves the great work of development to the master who monopolises the remaining twenty-six hours of the week's work.

XXXII. "The time allowed to the 65 boys who learn the subject is one period a week of forty-five minutes."

XXXIII. "All the pupils who are taught chemistry—491—devote two hours per week to the subject, and 110 of these have, in addition, a weekly lesson in laboratory practice, lasting one hour and a half."

(To be continued).

NOTICES OF BOOKS.

Gas-Works Statistics, 1888. Compiled from Special Returns received from Engineers and Secretaries throughout the United Kingdom. Edited by C. W. Hastings. London: Hazell, Watson, and Viney.

As we have had occasion to remark on former occasions, gas-producers are more communicative than the gatherers and distributors of water. Few gas-works seem to have omitted answering the questions addressed to them as to their make. We notice that in some half-dozen towns the production and consumption of gas exactly balance each other. In two towns, thanks possibly to the depraved ingenuity of the meters, more gas has been sold than made; and Barnard Castle, though making 14,300 thousand cubic feet of gas, has been unfortunate enough to sell only 1200.

A peculiarity, for which the compiler cannot be held responsible, is that the returns are not for identical seasons. Whilst some gas-works have sent in their accounts down to the end of March in the present year, others come down only to dates in 1885, 1884, and two—Alton and Spondon—furnish information respectively only down to the middle and the end of 1882.

As regards illuminating power, Berwick still heads the English list with 30-candle power, a figure not uncommon in Scotland, where Banchory leads with a 33-candle gas. The question has been raised whether such very high illuminating powers are not uneconomical, in cold weather, when certain hydrocarbons are in danger of being condensed in the mains and service-pipes.

Water-Works Statistics, 1888. Edited by Charles W. Hastings. London: Hazell, Watson, and Viney, Limited.

These statistics have been greatly improved. We now find, in parallel columns opposite the names of the towns or districts, the source of supply, the character of the water, the extent of supply, the death-rate, the quantity raised per annum, and the character of the service as constant or intermittent, besides information of no sanitary moment, though interesting to investors. It is to be regretted, however, that the returns given by officials are sometimes very deficient and even unmeaning. The column "Source of Supply" is evidently intended to show the geological character of the gathering grounds, or of the strata in which the wells are sunk. But one town actually writes under this head "pumping and gravitation" (!). Fully half the towns do not give their death-rate, and on the character of the water we meet with very various information. Some towns give the hardness—permanent and temporary—of their water-supply. It is evident that, if these figures could be universally obtained, we could find a definite answer to the question as to the relative wholesomeness of hard and soft waters; but not a few towns tell us merely their water is "excellent," "very good." We need scarcely say that these shortcomings are in nowise due to any neglect on the part of Mr. Hastings, as he cannot enforce answers to his enquiries. Aylesbury and Tring still observe a solemn silence as to their water, which is the more strange as the Chiltern Hills Water Company, which supplies these towns, has no reason to be ashamed of the quality furnished.

The information concerning the adoption of the Clark process for softening chalk waters is not so full as we might wish. In one case we find it stated in a footnote that a certain water "requires to be hardened." We should venture to suggest that the average daily supply per head of the population would be a more interesting item of information than the quantity raised (or collected) per annum.

The Extra Pharmacopœia: with the Additions introduced into the British Pharmacpœia, 1885. By W. Martindale, F.C.S.

Medical References, and a Therapeutic Index of Diseases and Symptoms. By W. Wynn Westcott, M.B. Fifth Edition. London: H. K. Lewis.

The present edition of the former work shows no falling off from its predecessors in point of utility. A considerable number of new remedies, natural and artificial, have been more or less engaging the notice of the medical profession, and are here duly noticed. The uses of cocaine are especially discussed at great length.

We must demur to the statement that magenta, unless specially prepared for medicinal purpose, *always* contains arsenic. Some large makers obtain this dye by Coupier's process, in which arsenic is not at at all employed.

Saccharine comes in for full consideration. It is admitted that its alkaline preparations have a mawkish taste, and that in the pure state a "flavour of bitter almonds is slightly developed." It is added that the taste of saccharine remains longer upon the palate than that of sugar. Probably the French experts were right in pronouncing it useful as a medicament,—*e.g.*, in diabetes,—but inadmissible as an ingredient in articles of food and drink.

Detection of Hydrogen Sulphide in Urine.—F. Müller.—The author passess through the sample a current of air which has been freed from sulphuretted hydrogen by a previous passage through potassa lye, and allows it to issue through a narrow tube, at the mouth of which is a slip of paper saturated with an alkaline solution of lead acetate, and which will turn brown if sulphuretted hydrogen is present.—*Zeitschrift f. Anal. Chem.*, xxvii., Part 1.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed

Moniteur Scientifique, Quesneville.
Series 4, Vol. ii., July, 1888.

Summary of Improvements in Dyeing, Tissue Printing, and Bleaching during the Second Half of 1887.—Dr. Paul Julius.—The author notices in the first place artificial colours for cotton. Since it has been found that certain azo-colours dye cotton without a mordant all manufacturers seek to add to their number. The investigators follow two distinct methods: some endeavour to substitute for the bases already known as producing cotton colours, such as benzidine, tolidine, dianisidine, &c., other new amines. Others seek among the number of phenols, amines, and their sulphonic or carbonic compounds for those which have not been already claimed by prior inventors, and they thus derive new colours without scientific effort. Among the principal cotton colours lately brought out during the latter half of 1887 are the rosazurine G and R and heliotrope of the company, formerly Fr. Bayer and Co. They bear acids well. The colours produced by the Berlin Aniline Company under the names Congo brilliant G and R are also relatively fast to acids. Fr. Bayer and Co. produce a benzo-purpurine 6B. Casella and Co., of Frankfurt, have introduced a new cotton red under the name of diamine red 3B. Delta-purpurine is a mixture of the colour just named and a dye verging on Congo brilliant. Fr. Bayer and Co. and the Berlin Aniline Co. have brought out a new cotton yellow under the name of chrysamine R. The black violet of the Baden Aniline Co. behaves on the fibre in the same manner as congo and benzo-purpurine. Acids turn it to a blue-black, but do not strip it. With basic colours it plays the part of a mordant. The number of colours prepared with diamido-stilbene-disulphonic acid is still more considerable than that of the congo group. Leonhardt and Co. have thus brought out so-called Hessian yellow, violet, and purple. These colours are injured by the smallest quantity of a salt of copper, and have to be dyed in wood or tin pans. The (Berlin?) Aniline Co. has patented colours derived from stilbene and playing the double part of dyes and mordants. Brooke, Simpson, and Spiller have produced primuline yellow, which dyes cotton at once in a boiling bath, and which may be converted on the fibre by special treatment into "ingrain red" and "ingrain orange." The Berlin Aniline Co. announce that all the "congo" colours and the derivatives of stilbene fix themselves upon wool at a boil. The process is very slow, but the shades are absolutely fast to the most severe fulling. Casella and Co. also send out two fulling reds, which are not very beautiful. The Baden Aniline Co. produce rhodamine, a colour belonging to a novel group. By its basic character and its dichroism it borders on the saffranines, but it is distinguished from them by the colour of its solution in monohydrated sulphuric acid, which is brown and not blue or green. J. Walder prepares a novel anthracene colour by the action of anthraquinone-disulphonic acid upon sodium nitrite. The Baden Co. sell an alizarin black which resists light better than the logwood blacks. J. R. Geigy produces two new vegetable colours, xanthaurine and anthracine. These extracts, with mordants of acetate of chrome, alumina, or salt of tin, yield all the shades from pale yellow to old gold. Zulz affirms that Indian yellow is probably a product of animal excretion.

New Analytical Methods.—We find under this head a process for the joint determination of caustic and carbonated alkali, proposed by Isbert and Venator. The sample is diluted and a few drops of an alcoholic solution of rosolic acid are added. Normal acid is then dropped in until a distinct yellow colour appears in the cold. This point shows the saturation of the free alkali. The liquid is then kept at a boil, when the red colour returns and the acid is again dropped in until a permanent yellowness appears. The acid employed shows the quantity of alkali as carbonate.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Blown Oil.—I have been much struck at times with the indefiniteness of the information afforded by authorities on various subjects, and especially is this true of the treatment of oils. As an instance, I desired to know how to prepare "blown oil" mentioned on page 129 of Mr. A. H. Allen's valuable work, but was not afforded much information on the subject. He says, "Blown oil is manufactured by blowing air through warm rape, cottonseed, or other oil. Great heat is developed, and the oil gradually increases in density and viscosity till it presents a close resemblance to castor oil." He does not give any information as to the heat to which the oil should be raised before the blowing, or how much heat would be developed, or the duration of the blowing. Brannt is less satisfactory, not mentioning the subject at all. I have found Mr. Allen's work very satisfactory in the main, but in many places it seems to be wanting in definiteness, as in the above case. What I desire now is information from any of your subscribers which will shed more light on the subject.—WILLIAM JAMES MULLINS, Chemist.

TO CORRESPONDENTS.

A. C.—Sodium hydrate in solution has no injurious action on iron or steel, and its use in steam boilers has been advocated by Mr. Spiller for the prevention and cure of incrustation.

Mr. R. R. Tatlock writes to say, with reference to the paragraph on p. 149 of the "Students' Number," that the firm of Messrs. Wallace, Tatlock, and Clark, of 138, Bath Street, Glasgow, no longer exists, and that the firm with which he is now connected is that of Messrs. R. R. Tatlock and Readman, City Analyst's Laboratory, 156, Bath Street, Glasgow. (See Advertisement).

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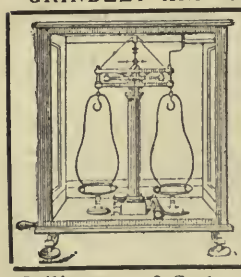

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1506.

ON THE

ABSORPTION SPECTRUM OF OXYGEN.

By Professors LIVEING and DEWAR.

The observations here described are the outcome of experiments which we have commenced on the spectra of gases under high pressure. The gases were contained in steel tubes, and the first difficulty to be overcome was the provision of windows capable of sustaining a pressure of 250 atmospheres. For this purpose the tubes were provided with gun-metal ends carefully fitted with curved conical bearings forced home with powerful screw caps. These gun-metal ends were perforated with conical holes, to which were fitted quartz stoppers with plain polished ends. The stoppers were 2·1 centimetres thick and of the same diameter at the smaller end. They were bedded in the openings of the gun-metal with a thin layer of wax to insure a large bearing surface, without which they are liable to fracture in the planes of greatest pressure. The tubes were likewise fitted wtth screw-valves near each end for the admission and escape of gas. Two steel tubes were used, each 5 c.m. in diameter, one 1·6 metre long and the other 18 metres long. The shorter tube had in it at its centre a quartz lens of rather less diameter than the tube, and of such focal length that when a light was placed 15 c.m. from one end of the tube an image of it was formed on the slit of a spectroscope at about the same distance from the other end. The longer tube had two such lenses in it, one about 30 c.m. from each end, so that when a source of light was placed in the focus of one lens a beam of parallel rays passed through the greater part of the tube and was collected upon the slit of the spectroscope by the other lens. These lenses were each held in place by three springs pressing against the walls of the tube. The soundness of the tubes and stoppers was tested by water pressure by means of a Cailletet pump, up to 260 atmospheres. The oxygen used was ordinary oxygen, previously compressed into an iron bottle. The gas was first allowed to stream through the tube, both valves being open, until all the air was expelled. The exit tube was then closed, and the pressure of the oxygen allowed to rise in the tube, and the spectrum was examined from time to time at different stages of pressure. The light employed was an arc lamp.

Using the shorter tube filled with oxygen at a pressure of 140 atmospheres, the following absorptions were visible :—

1. A narrow very black band in the extreme red, distinctly divided into two parts, well-defined on the more refrangible side, and diffuse on the less refrangible side, coinciding in position with A of the solar spectrum. We were unable to resolve this band into lines, even by the use of a large spectroscope and one of Rowland's large gratings, although the red potassium lines, produced by sprinkling a little of a potassium salt on the electrodes of the lamp, were seen through the tube sharply defined and widely divided.

2. A similar, but less strong band, also distinctly divided into two parts, but not further resolvable, in the position of B of the solar spectrum.

3. A broad dark band in the orange, diffuse on both edges, and extending from about λ 6360 to 6230, covering the place of α, which could not be detected.

4. A stronger and broader dark band in the yellow (Brewster's δ), diffuse on both edges, but rapidly coming to a maximum intensity on the less refrangible side, and extending from about λ 5815 to 5675. The maximum intensity of this absorption was at about λ 5785.

5. A faint band in the green at about λ 5350.

6. A dark band in the blue, diffuse on both edges, extending from about λ 4795 to 4750.

7. A very faint band in the indigo at about λ 4470.

When a photograph was taken with a light through the tube, all rays above λ 2665 or thereabouts appeared to have been absorbed, and the light began to diminish at about λ 2705.

When the pressure of the oxygen was further increased to 165 atmospheres the intensities of the aborption bands were increased and the diffuse edges a little widened, but no new bands were noticed. When the pressure was let down the reverse effect followed.

At 115 atmospheres the faint band in the indigo, λ 4470, was hardly traceable, and the other absorptions were weaker, and A, though weaker, was more sharply defined.

At 105 atmospheres the band in the indigo had disappeared.

At 90 atmospheres A and B were still well seen and sharp, all the bands weaker, that in the green hardly visible.

At 45 atmospheres A was still well seen, B just visible, the other absorptions very faint indeed.

At 40 atmospheres A was still well seen, B had disappeared, and of the other bands only a trace of the strongest in the yellow was left.

At 30 atmospheres A could be still seen, but the bands were all gone.

A continued to be visible when the pressure was further reduced to about 20 atmospheres. To see it easily it was necessary to use a wide slit and cut off some of the brighter part of the spectrum with a piece of cobalt-blue glass.

The radiation absorbed by the oxygen at high pressure caused an increase in the pressure in the tube, which amounted to nearly 5 atmospheres.

As these absorptions were produced by uncombined oxygen, it was a matter of interest to determine whether the compounds of oxygen would produce anything like them. Angström's observations had shown that aqueous vapour did not produce them in the visible part of the spectrum. Miller had determined that aqueous vapour absorbs very little of the ultra-violet rays. We tried, however, carbonic acid gas and nitrous oxide, both at pressures of about 50 atmospheres, but in neither case did a column of the length of our tube give any visible absorption band. A photograph showed that the nitrous oxide cut off all light above λ 2450 or thereabouts, but this is a point much higher than that at which complete absorption by oxygen begins.

These observations establish the remarkable fact that oxygen does not carry with it into its compounds its absorptive power, and that the compounds are more transparent, within the range of the radiations we have observed, than the element itself. Hartley found that oxygen, with a small percentage of ozone at atmospheric pressure in a column 36 inches long produced an absorption in the ultra-violet extending from λ 285 to 232, and that there was a feeble transmission of light above λ 232. Our photographs did not show that any light in this highest region was transmitted through the compressed oxygen.

The absorption bands we have observed appear to be identical with those observed by Olszewski to be produced by a thin layer of liquid oxygen. He describes them as extending from λ 634 to 622, from λ 581 to 573, at λ535, and from λ 481 to 478. The band seen by us in the indigo is very faint, so that it is not surprising that he should not have noticed it. A would be rather difficult to see under the circumstances under which Olszewski worked, so that it may have been present, though unobserved (*Wied. Ann.*, xxxiii., p. 570).

Janssen says (*Comptes Rendus*, April 16, 1888) that he had observed the same bands as Olszewski, using compressed oxygen, and that the absorptions are divisible into two series :—

1. Those resolvable into lines, of which the intensity is proportional to the product of the thickness of the stratum into the pressure of the gas directly. To this series A and B belong.

2. Those not easily resolvable into lines, of which the intensities are proportional to the product of the thickness of the stratum into the square of the density. To this belong the other bands.

It is very probable that the reason why we did not succeed in resolving A or B into lines was because the lines were so much expanded, owing to the density of the gas, as to obliterate the interspaces. This is borne out by the observation that the more refrangible edge of A became more sharply defined when the pressure was reduced.

All the bands we observed, except that in the indigo, appear to be identical in position and general character with bands observed by Angström in the solar spectrum, and found by him to be persistent in time of extreme frost, when the lines due to aqueous vapour were dried out. But although the quantity of oxygen through which we observed was, even at the highest pressures employed with the shorter tube, considerably less than is contained in a vertical column of the earth's atmosphere of the same section as our tube, the bands we observed were far stronger than those in the solar spectrum. This tallies with Janssen's law above given, that the intensities of these diffuse absorptions vary as the square of the density of the absorbent gas.

We next tried the effect of the longer column in the tube 18 metres long. Filled with atmospheric air at ordinary pressure it gave no absorption which could be detected, but when oxygen at atmospheric pressure was substituted for air, A could be seen though B was not visible, nor any other absorption. As the pressure was increased first B came out, and then the band in the yellow above D. At 20 atmospheres the bands in the orange and blue were just visible. At 30 atmospheres A was very strong indeed, B strong and sharp, the bands in the orange yellow and blue were quite strong, that in green just seen, and that in the indigo doubtful. The pressure was gradually increased up to 90 atmospheres, when the quantity of oxygen in the tube was about equal to that contained in a vertical column of the earth's atmosphere of the same cross section. The increased density very much increased the intensity of all the bands, but brought out no new bands in the visible spectrum. There seemed, however, to be a general absorption at the red end, extending to about one-third of the distance between A and B, which somewhat obscured A. B remained quite sharp, the diffuse bands were somewhat expanded, and the bands in the green and indigo were well seen, though still not very dark.

Photographs showed a new band, though rather weak, just above the magnesium triplet, near L of the solar spectrum, a stronger absorption band extending from about λ 3640 to 3600, and a diffuse broad band over O. Above P there appeared to be complete absorption, as an exposure of a very sensitive plate for ten minutes brought out no impression beyond about λ 3360. Egoroff (*Comptes Rendus*, ci., p. 1144) found that traces of A remained visible when the layer of atmospheric air through which he looked was reduced to 80 metres. We were able to see A produced by a column of oxygen equivalent to 90 metres of atmospheric air.

Janssen (*Comptes Rendus*, ci., p. 650) says that in the absorption spectrum of oxygen at a pressure of 27 atmospheres in a tube 60 metres long there are rays between A and B and between B and C. Our tube, 18 metres in length, filled with oxygen at 90 atmospheres, would contain the same amount of gas as a tube of the same section 60 metres long, filled at a pressure of 27 atmospheres, but we could see no trace of the rays in question.

Observing through the tube a sheet of white paper so placed as to be strongly illuminated by the sky, the transmitted light appeared to the the naked eye to have a faint blue tint, similar to that presented by liquid oxygen, and due, no doubt, to the amount of absorption in the orange and yellow.

When some of the gas was allowed to escape, so as to reduce the pressure, the tube became almost or quite opaque. When not quite opaque the light transmitted appeared to have a greenish tint. In this case a cloud may have been formed and may have caused the opacity. When gas at high pressure was entering the tube some curious appearances presented themselves. If the gas came in slowly it appeared, on looking through the tube, as if two liquids which do not mix, one black and the other colourless, were being stirred together; and if the gas entered at all rapidly the tube became absolutely opaque. We suppose this must be due to reflexion at surfaces where there was a change of density. When the stream of entering gas was cut off the tube remained opaque for more than a minute and only gradually resumed its transparency. Precisely similar appearances could be produced by heating the tube at one or two points. When the gas was at rest in the tube the arc light seen directly through it was unbearably bright, but it was completely extinguished when the currents were set up in the tube. It is evident from this that currents of different densities in the atmosphere of a star may entirely cut off all the light coming from the interior.

It appears, too, from the strong absorption of the ultra-violet rays by oxygen that we have little chance of knowing what high ultra-violet rays are emitted by stars unless we can make our observations from points very high in our atmosphere, and unless the atmospheres of the stars contain but little free oxygen.

The whole series of observations suggest points about which interesting speculations arise. The absence in the compounds of oxygen of all traces of the absorptions produced by the element may perhaps be due to a shift of these absorptions on the scale of wave-lengths. The vibrations assumed by carbonic acid gas, for example, may be harmonically related to those of oxygen, but be higher or lower on the scale and beyond the range of our observations. The increase of the diffuse absorptions with the square of the density of the gas may be interpreted as an indication that it is only during encounters of the molecules that the corresponding vibrations are taken up. It should be observed, however, that Janssen does not, in the note above quoted, give any very definite data by which the exact truth of his law can be verified, though it seems to be established that the intensities of these absorptions increase more rapidly than the density of the gas. The distinction, too, between the bands easily resolvable into lines and those not so easily resolvable seems to be one of degree only, as we were unable to resolve A or B as given by the dense gas, and Angström has observed that the band in the yellow, Brewster's δ, in the solar spectrum was resolved into fine lines when the sun was high, but appeared as a continuous band when the sun was low. Increase of density in the gas seems to expand the bands in every case, and estimates of the intensity of A may be estimates rather of the breadth of the lines than of their absolute blackness.

ANALYSES OF TWO MONEYS.

By J. CUTHBERT WELCH, F.C.S.

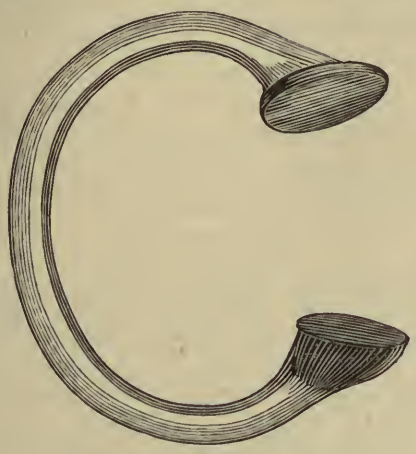
I. Some time ago several specimens of "manilla money" came into my hands, and curiosity, added to a statement I had several times heard made—that in their manufacture refuse scraps of various old metals were thrown into the melting-vessel—led me to determine the composition of some of them.

This money is made in Birmingham and I believe by several firms, and is used by the natives on the West Coast of Africa. It is of a yellowish-red to reddish-yellow, brass to bronze-like colour, and of the shape and

size given below, and weighs $2\frac{7}{16}$ ounces, avoir. Three specimens, homogeneous in appearance, gave the following results on analysis :—

	I.	II.	III.
Lead	23·92	19·54	16·81
Iron	0·82	0·31	2·15
Tin	2·70	0·04	1·56
Copper . ..	65·48	71·84	75·62
Zinc	2·65	3·41	1·02
Antimony ..	2·01	3·56	0·35
Arsenic ..	2·12	1·03	2·71
	99·70	99·73	100·22

Some of the specimens were very easily broken by pressing the two ends towards each other in the hand. This appeared to be due to two causes : firstly, to imperfect casting and flaws in the metal ; and secondly, to the



presence of pieces of originally unmolten metal in the body of the coin. In three cases this particular piece was separated as completely as possible from the matrix, and analysed with the following results :—

	I.	II.	III.
Lead	30·25	4·56	22·56
Iron	4·12	2·63	1·34
Tin	0·51	—	—
Copper . ..	64·18	89·94	74·15
Zinc	0·62	2·47	0·32
Arsenic ..	—	—	0·41
Aluminium..	—	0·24	0·73
Carbon . ..	—	—	0·24
	99·68	99·84	99·75

Nos. I. and II. seemed fairly homogeneous, but in the case of No. III. it was impossible to obtain a really fair sample, the mass having only a semi-fused appearance. The determination of the carbon, too, cannot be relied on, it probably being rather low.

A fourth specimen broke, due to the inclusion of a piece of scoriaceous material.

Thus the coins seem to be composed of a variable alloy of lead and copper with small quantities of other metals, but no aluminium ; and in those cases where fracture on pressing the ends together occurs through the presence of non-homogeneous material the composition seems very variable, and the part causing fracture has the appearance of being an imperfectly fused portion of the original mixture.

II. A coin, having at first sight the appearance of a very much worn half-sovereign, on closer inspection revealed on one side a small white surface as though an old sixpence had been gilt, but on rubbing the coin to polish it this white surface gradually diminished and finally disappeared. It then became evident that in reality it was an alloy very similar to gold in colour that had been coated with silver and circulated in imitation of an old sixpence.

On analysis the alloy gave :—

Copper	62·583
Zinc	37·262
Iron	0·106
Lead	0·013
	99·964

The Brewery, Reading.

ON THE DETERMINATION OF PHOSPHORUS IN IRON AND STEEL.

By PORTER W. SHIMER, M.E., Easton, Pa.

The solution used in the following method for phosphorus determination is the filtrate obtained in the nitric and sulphuric acid method for the determination of silicon (*Transactions of the American Institute of Mining Engineers*, vii., 346). This filtrate, being easily and quickly obtained, and always quite free from silica, is a desirable one for phosphorus precipitation. In order, however, to get all the phosphorus in a precipitable form the solution must be made under conditions more strongly oxidising than simple solution in boiling nitric acid. In a solution thus made I have found that the presence of a moderate amount of free sulphuric acid does not prevent complete precipitation of the phosphorus.

The method in detail is as follows :—Dissolve 1 grm. of iron in 20 c.c. HNO_3, sp. gr. 1·20. Add to the boiling solution 10 c.c. potassium permanganate solution (20 grms. to 1000 c.c. water, filtered), $2\frac{1}{2}$ c.c. at a time. After a few minutes, when the permanganate is decomposed, leaving a heavy precipitate of MnO_2, add 5 c.c. HCl, 1·12 sp. gr. When the effervescence due to the escape of chlorine has ceased, add a mixture of 5 c.c. strong H_2SO_4 and 5 c.c. water. Remove the watch-glass and evaporate till fumes of SO_3 begin to come of. Allow to cool and add 5 c.c. HNO_3, 1·20 sp. gr., and enough water to dissolve the residue. Boil till all iron salts are dissolved, and filter, washing with water alone. Set aside the filtrate for phosphorus determination. It need not be concentrated by evaporation when unnecessary excess of wash-water is avoided. For silicon the residue should be washed a few times with HCl and water to remove possible traces of iron, but these washings should not be added to the phosphorus solution. The latter is heated to 80° C. and 50 c.c. ammonium molybdate solution is added (5 grms. MoO_3, 20 c.c. NH_4HO, sp. gr. 0·96, and 30 c.c. HNO_3, sp. gr. 1·20). Heat to 60° C. till the supernatant liquid is perfectly clear. When the solution is not too dilute, precipitation is complete in less than one hour. The yellow precipitate is filtered off, washed with acid ammonium nitrate solution, dissolved in ammonia and precipitated by magnesia mixture. The ammoniacal solution is more generally colourless and clear than that obtained by the usual method. Whenever this solution is not perfectly clear and colourless, it is my custom to dissolve in HCl whatever gelatinous residue there may be upon the paper, allowing the acid solution to drop into the ammoniacal filtrate below until it becomes acid, thus throwing down the yellow precipitate. Add a slight excess of ammonia and boil for a few minutes. Filter off the precipitate, dissolve it on the paper in a few drops of HNO_3, and add ammonium molybdate solution. Add the ammoniacal solution of the yellow precipitate thus obtained to the main solution. The latter is then precipitated with magnesia mixture in the usual manner.

When the solution of the iron is made above, no phosphorus can escape complete oxidation, for it is subjected

to the following oxidising agencies:—Solution in boiling HNO_3, action of potassium permanganate solution, action of chlorine given off by reaction of HCl on precipitate of MnO_2, action of chlorine given off by mixture of strong HCl and HNO_3, evaporation and heating till fumes of SO_3 appear, solution of residue in water and HNO_3. These agencies may also be desirable for the oxidation of silicon, for there is reason to suspect that this element is not easily oxidised in some irons.

The following are some comparative results obtained. The "standard" method is the usual one of solution in HNO_3; evaporation to hard dryness; solution of residue in HCl; replacement of HCl by HNO_3, precipitation by molybdate solution, and final precipitation by magnesia mixture.

	Standard Method. Phos. per cent.	Method above described. Phos. per cent.
A	1·75	1·74
	—	1·76
	—	1·76
B	3·623	3·639
	3·641	3·637
C	0·560	0·558
D	0·394	0·397
E	0·582	0·588
F	0·073	0·072
	—	0·074
G	0·749	0·749

In the Bessemer iron ("F") 5 grms. iron and 8 c.c. H_2SO_4 were used. Sample "B" is a white iron, containing 2·27 per cent combined carbon and 0·08 per cent graphite. In sample "G" Mr. Lee S. Clymer, Chemist of the Durham Iron Works, obtained by the usual acetate method 0·743 per cent, and, by applying the acetate method to the filtrate from the silicon as above, he obtained 0·743, 0·740 per cent phosphorus.

The exactness with which the kind and amount of free acid can be controlled in this solution for molybdate precipitation, and the comparative purity of the yellow precipitate in case of titanic irons, would probably make it well adapted either for weighing directly or for solution, reduction, and titration, according to the method described by F. A. Emmerton (*Transactions*, xv., 93).

N. H. Muhlenberg and Thomas M. Drown (*Transactions*, x., 85, 329) evaporate the solution of the iron in nitric and sulphuric acids to dryness and heat till SO_3 fumes cease coming off. The phosphorus results obtained in this way are accurate, but the silicon results are too high. It is unnecessary, however, to drive off dense volumes of these irritating fumes, for complete precipitation depends not upon the absence of free sulphuric acid, but upon complete oxidation of phosphorus, and of the carbon compounds resulting from solution of combined carbon in nitric acid. Moreover, a certain amount of free sulphuric acid is necessary for a good silicon determination.

It may be interesting to add the results of a few experiments with a molybdate solution containing sulphuric acid in place of nitric acid. The solution for phosphorus precipitation was made as above, with the exception that the residue on evaporation with H_2SO_4 was dissolved in water alone, instead of water and nitric acid. This solution was heated to 80° C., and precipitated by a molybdate solution, made by dissolving 5 grms. MoO_3 in 20 c.c. NH_4HO, sp. gr. 0·96, and adding 30 c.c. dilute H_2SO_4 (1 part strong H_2SO_4 to 4 parts water). After heating for one half-hour to 60° C. precipitation was complete. The following are the results:—

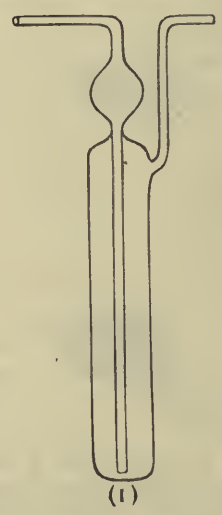
	By Standard Method. Phos. per cent.	By Use of Sulphuric Molybdate Solution. Phos. per cent.
A	1·75	1·75
B	3·63	3·64

It will be noticed that in these precipitations sulphuric acid and ammonium sulphate completely take the place of nitric acid and ammonium nitrate. Another experiment on the iron marked "B," in which, however, 25 c.c. more free sulphuric acid was present than in the above tests, gave only 3·09 per cent phosphorus, showing that a too large excess of free sulphuric acid, like too large an excess of free nitric acid, prevents complete precipitation.

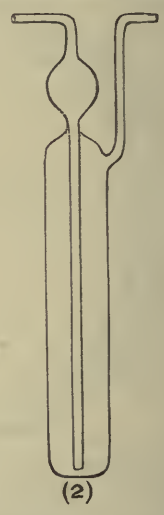
MODIFIED ABSORPTION TUBES.

By JOHN TSAWOO WHITE.

I would suggest a modification of the absorption tubes used in organic analysis. The accompanying illustrations of the proposed tubes require no explanation. They are for liquid absorbents. The body of the tubes may be about 10 c.m. long and 1½ c.m. in diameter. The tubes

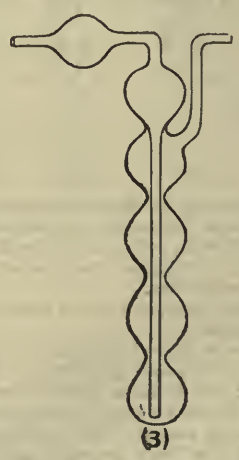


(1)



(2)

need not be more fragile than the ordinary ones of light blown glass. The first form is for absorbing water with strong sulphuric acid. For absorbing carbon dioxide a combination of the two forms is used. The first tube is



(3)

half filled with a solution of caustic potash of sp. gr. 1·27, and the second tube contains sulphuric acid to absorb the traces of vapour given off from the potash solution. The exit tube of the potash bulb may contain some cotton-wool.

The potash solution will absorb a little over 0·8 grm.

carbon dioxide to form the monocarbonate. If this is thought not sufficient the caustic solution, one part of caustic potash dissolved in one part of water, recommended by Löwe, may be used. A second potash bulb may be added if complication of apparatus is of no moment. The tubes are connected with rubber tubing. The pressure of gas in the tubes will aid absorption; the pressure need not be too great when working in a stream of oxygen, aided by an aspirator. The potash bulb may also be of the form given in illustration (3), a form similar to one devised by Mitscherlich. The points where the tube is contracted must not be narrowed too much, or else the solution pushed upwards may force its way out by the exit tube.

As these absorption tubes cannot be made here, I have not been able to try them; but I may claim for them simplicity of construction and light weight, and last, though not least, accuracy, as they are formed on the same principles as those now in use.

Rangoon College, August 20, 1888.

REPORT OF THE COMMITTEE*

APPOINTED FOR THE PURPOSE OF INQUIRING INTO AND REPORTING ON

THE PRESENT METHODS OF TEACHING CHEMISTRY.†

(Concluded from p. 160).

(iv.) A CONSIDERATION of these replies has fully established the important fact that the chemical instruction which is given in schools is very largely influenced and guided by the requirements of the various Examining Boards, such as those of Oxford and Cambridge and of the Science and Art Department. Abundant testimony has been received on this point, and it is frequently declared to be a great, though apparently an inevitable, evil. The quotations cited below are selected as representing schools of very different grades.

XXXIV. "The influence exerted by external examiners on the character of the teaching. This has always been to me the most subversive of good teaching, and most damaging to the character of the work. I have had a large experience in the working of the various public examinations, and I unhesitatingly say that they cripple the work of teachers, afford no safe index as to the quality of the work, and lead to a system of book-work cram which militates against anything like mental discipline and against subsequent instruction in the higher branches of the subject."

XXXV. "But all difficulties are nothing compared with those that arise from the personal peculiarities of examiners. Unless with special pupils who, having spent most of their time on chemistry, have been able to acquire some knowledge of all its branches, a teacher is never sure that he will be able to prove to an examiner that he has taught any chemistry at all."

XXXVI. "It will be seen that the examinations for which our pupils are prepared are those of the Cambridge Local, the College of Preceptors, and the Science and Art Department, and the preparation for each is so varied that it has a very bad influence."

XXXVII. "The influence of external examiners, in my opinion, is too often to encourage mere cramming to meet out-of-the-way questions."

XXXVIII. "A class was formed from the pick of the school in connection with the Science and Art Department. My salary to a certain extent depended on the results of the May examinations. Since the number in the class had to be limited, I naturally chose only those boys who I thought would have the best chances of getting through. For a great part of the year chemistry would be treated as a by-subject, it was only for a month or so that it had its due share in the curriculum of the school, and I must conscientiously admit that during the short period before the examination I simply crammed the minds of my pupils with equations, properties, graphic formulæ, to such a degree as to ensure passing, which they all did. I was not surprised to find that in a short time all had been forgotten. This system is adopted at many places."

XXXIX. "The teaching of chemistry here is entirely regulated by the Science and Art Department, for the simple reason that it would not exist as a class subject without the pecuniary aid rendered by the Department. I believe some really good work is being done; but the teacher is very much of a machine, and however conscientious he may be, he must primarily, under the circumstances, teach for examination, and at times neglect what would be useful to his pupils because it would not be useful for examination."

XL. "In this school chemistry is optional, and the primary object of its existence is the advantage of those boys who are going in for examinations in which it will prove useful."

XLI. "There is great variation in the standards and methods of various examinations. Three things are specially to be complained of:—(*a*) the bookish nature of some examination papers; (*b*) estimation of the value of answers by comparison with text-books by inferior men, not always the authors of the papers or themselves real chemists; (*c*) want of judgment in setting papers, arising often from ignorance at first hand of the conditions of school work."

XLII. "With respect to examinations, I do object to men examining boys under sixteen who have never taught them, and who, therefore, do not understand that the work of such students must differ not only in quantity, but also in quality from that of older pupils."

XLIII. "I believe that 90 per cent of those who are now taught chemistry in this country are taught with the view of passing one or other of the examinations held on the subject. Further, I believe that most of the difficulties of teaching chemistry are difficulties of teaching it so as to comply with the requirements of examinations. Some one has said that in the regulations of the Science and Art Department so much is required to be known that there is no time for anything to be done, which is an exaggeration of what I mean. With ordinary teachers one thing is necessary—their pupils must pass. When that is secured they may indulge in such novelties of method and procedure as they like, but not until then. It would avail me nothing to say that my instructions were faulty, that I knew and followed a more excellent way."

XLIV. "As to the influence of examiners. In my own teaching it has been for the last few years *nil*. I have given up trying to fit the chemical instruction to the doubtful requirements of examination; to do so would take the vitality out of one's teaching and contract it."

XLV. "With regard to the influence of external examiners on the teaching, there is no doubt that this is very great, and that the character of the teaching in our schools must depend, in these high-pressure examination-days, on the requirements of the examiners."

XLVI. "We have subjected our boys to two examining bodies—the Science and Art Department and the University Board. In successive years the boys from the same teaching universally succeeded under the former and almost universally failed under the latter."

XLVII. "The examinations have been chiefly those held in connection with the Science and Art Department, South Kensington. These examinations have been for some years back highly satisfactory, and no undue prominence has been given to any one branch of chemical

* Consisting of Prof. H. E. Armstrong, Mr. J. T. Dunn, Prof. W. R. Dunstan (Secretary), Dr. J. H. Gladstone, Mr. A. G. Vernon Harcourt, Mr. Francis Jones. Prof. H. McLeod, Prof. Meldola, Mr. Pattison Muir, Dr. W. J. Russell, Mr. W. A. Shenstone, Prof. Smithells, and Mr. Stallard. Drawn up by Prof. Dunstan.

† Read at the British Association, Bath Meeting, Section B.

science. They certainly do exert an influence on the character of the teaching, but it is a restraining and beneficial influence."

XLVIII. "The influence exerted by external examiners on the teaching is decidedly beneficial *when the examiners are experienced men*."

XLIX. "The influence exerted by external examiners on the character of the teaching is practically *nil*. They send their questions and substances, examine the results, and write their reports, and, with rare exceptions, never make a suggestion as to how the teaching may be improved or better results obtained.

(v.) The absence of good text-books suitable for use in schools is frequently stated to be a source of difficulty.

L. "One of the chief difficulties in class teaching is the want of a suitable text-book, more especially when preparation is an important factor. A text-book should, without any great amplification on the part of the teacher, make itself intelligible to the boy on reading it for the first time, and it should not be overladen with facts."

LI. "We want a good school text-book. Existing books entirely lack connection in their various parts, and are generally made up of a series of more or less isolated facts grouped loosely under various heads. They are also too diffuse and wordy, and, therefore, very unsuited to a boy with but a limited time to prepare his lessons."

LII. "An additional difficulty is found in the absence of a satisfactory text-book, notwithstanding the multitude already extant, and this difficulty is not diminished by the consideration that, as a rule, the science master is required to devote a great portion of his time to teaching other subjects. According to my idea, the kind of book required is one that recognises the close connection between the lecture work and the practical work of the pupil; in fact, a book something after the plan of Huxley and Martin's 'Biology.'

LIII. "The greatest difficulty we meet in teaching chemistry is the want of a suitable text-book on which all our lecturers can base their teaching. Boys sometimes get different definitions of the same term, and a master does not know exactly how much boys have learnt in another class."

LIV. "Text-books are another difficulty. I have never found one yet that I liked to put into the hands of boys, for I have generally found that they are too elaborate and complete, using, sometimes, language which the ordinary schoolboy does not understand, and describing here and there experiments which he certainly cannot grasp. I have not found a book which I could put between the 'Chemistry Primer' (which, with the 'Physics Primer,' is always my preliminary course) and such a volume as Thorpe's or Roscoe's; these contain a great deal of matter too difficult and minutely exact for class work."

LV. "Further, there is the eternal text-book difficulty. A book at once clear, brief, and accurate is a desideratum."

(vi.) Some head-masters complain that they are unable to obtain properly qualified teachers of chemistry.

LVI. "Difficulties arise from the circumstance that there stands before the class a chemist who is not a teacher, or a teacher who is not a chemist."

LVII. "The scholastic disrepute in which the subject is held is apt to affect the teacher. It is much easier to obtain a well-qualified teacher of classics than an equally well-qualified one of natural science."

LVIII. "Our two great difficulties here are:—(1) To get men, for anything we can offer, who are at once chemists and teachers. Mere chemists are of no use from a pedagogic point of view, and even they would be hard to get. I am convinced that a *teacher* who had a strong grasp of the principles of the science could, and would, make it an eminently valuable means of mental training. (2) The entire non-recognition of chemistry by the two universities in the earlier stages of their arts courses."

3. "*The Methods which, in your Opinion, are most likely to render the Teaching effective as a Mental Discipline, and as a Preparation for Subsequent Instruction in the Higher Branches of the Science or in Applied Chemistry.*"

A great deal has been written in reply to the question as to the methods which ought to be followed in teaching elementary chemistry.

It is clear that the older plans of teaching, which are still largely used, are felt to be partly unsatisfactory, and that by modifying them chemistry might be made much more valuable as a mental discipline for boys. In particular protest is made against the undue proportion of time which is frequently assigned to qualitative analysis; indeed, the majority of teachers do not consider this to be the most valuable part of the subject. Others hold that it presents many advantages, and is, on the whole, the best adapted to school work, especially when instruction has to be given to large classes of boys. But while most teachers strongly deprecate a rigid adherence to the present system, and a few are able to point out the general lines on which the teaching might be more usefully conducted, it is evident that very few, if any, have yet put into operation a re-modelled system of instruction. In fact, it appears that teachers stand very much in need of advice and assistance in preparing a modified scheme of teaching suitable for general adoption in schools. It has several times been suggested that this Committee might be able to render important help in this direction.

The following quotations are typical of many of the replies which have been made. They are written by the head-masters or science masters of both large and small schools, and are here reproduced, not only because they allude to some of the principal defects of the present methods, but also on account of suggestions they contain which seem likely to be valuable to those who are anxious to make chemical teaching more effective than it is at present.

LIX. "The teaching should be experimental in all cases. The experiments need not be numerous, but apposite, and the utmost got out of them, both directly and indirectly. I find, for example, that I can get a good hour's work out of boys in the lower forms with such subjects as the separation of sand from a solution of salt, the action of water on lime, or the action of nitric acid on copper. I find that the same plan of limiting the attention to one or two important points is also most effective in the upper forms when the exigencies of examination-work admit of this kind of treatment. Notes of lessons should be relied on rather than text-books. I find, for example, that the ground covered at previous lessons is always known, but that I get next to nothing out of a set lesson from a book. This will be sure to follow from an experimental method of treatment. Above all, I would suggest the entire re-modelling of all school examinations, and the placing them in the hands of men who have had experience in teaching, and know, therefore, what to expect of boys, rather than in those of men fresh from the 'schools,' and with only the experience of university teaching. I should also like to see the range limited and the examination papers graded. The extent of the ground covered by the Local Examination papers of the universities is too great for such schools as this, though Oxford has recently much curtailed them.

"I am led to hope that your Committee may see its way to step in and produce something like uniformity and system. Would it not be possible to draw out a scheme of teaching divided into 'grades,' and suited to a progressive course, as also to issue yearly sets of examination papers adapted to these different grades? I sincerely trust that this may be one of the results of your inquiry, for I feel sure that examination by so high an authority will have a most beneficial effect on science teaching, and have a value in the hands of examiners impossible under any of the present systems."

LX. "It is, in my opinion, no use crying out against the system of examinations in this country. For years to come the nation will go on demanding results and getting them. Can those results be made more worth having? I believe they can. It lies entirely within the power of the eminent and working chemists of the country to effect great and useful reforms almost at once. It should be acknowledged that the present requirements are obsolete. Looking at the enormous and ever-increasing number of important and interesting facts, has not the time come when chemistry should be taught to beginners as biology is taught? Instead of reading about hundreds of plants and animals, a student becomes practically acquainted with about a dozen of each at first hand. Why should not a similar plan be followed in chemistry? Why should not a thorough study of chlorine include all that an elementary pupil needs to know about the halogens? The principal member of each group of the non-metallic elements might be selected for special study. As to the metals, half-a-dozen, which might be varied from year to year, if really mastered, would be much better than the knowledge which is required of them under the present system. Room would thus be found for a few organic compounds. It is pure pedantry to maintain any longer the arbitrary distinction of inorganic and organic chemistry in a firsr and general course. As to analysis, I think the present comparatively complete course should give place to a sound knowledge of the separation of some half-dozen substances, and the time thus saved could be devoted to easy exercises in quantitative analysis. There can be no doubt that quantitative analysis is within the reach of any student who can perform a good qualitative analysis. What I have proposed amounts to re-writing a syllabus for a first or general course of chemistry, on the basis of selecting a few typical substances and making a more or less complete study of them, and, with regard to analysis, to restrict the substances to be studied, but to require the elements of gravimetric and volumetric determinations."

LXI. "To render the teaching of chemistry of educational value it must be made inductive, and not chiefly and largely deductive. The guiding motto should be 'Prove all things.' Experiments should be made with as simple apparatus as will secure the desired result. In the earlier lessons avoid all definitions, all hypotheses of atoms and molecules, of atomic weight, and of 'bonds,' but early establish the constancy of composition of compounds and the equivalent weights of certain elements in combining with or displacing one another. I should like to see some encouragement given to the historical aspects of chemistry. I have found that explanations of when and how the chief elements, acids, and alkalies came to be known add much to an intelligent interest in the subject."

LXII. "It has always appeared desirable that a boy should approach chemistry in the same way that all the founders and builders-up of the science have done,—viz., not by first reading a printed account of facts and then verifying them or seeing them verified, but by studying the different forms of matter as substances hitherto unknown, the properties of which have to be investigated for the first time and compared with those of other substances. With this view the experiments shown are considered as questions put to Nature, the answers to which are as little known to the lecturer as to the learners. No predictions are made as to the results, although boys are not unfrequently asked what, arguing from experiments previously shown or the properties of analogous substances previously examined, may be expected to occur. *All* apparatus used is described, the reasons for any special arrangement of it being explained fully. Elaborate forms of apparatus with a profusion of drying tubes, Woulf's bottles, fantastically bent leading-tubes are avoided as far as possible, their tendency being to draw off attention from the main point of the experiment. The arithmetical side of chemistry is not very much enlarged upon; it seems hardly desirable that boys should look upon experiments as pegs on which numerical problems are to be hung. Too much time may easily be spent in elaborate calculations on the quantity of zinc required to obtain enough hydrogen to decompose the nitrogen monoxide produced from 10 grms. of ammonium nitrate. Innumerable examples, however, illustrative of important laws, such as those of Gay-Lussac and Avogadro, and of calculations actually required in quantitative work, are frequently set generally at the beginning of each lecture, in reference to some point explained in the preceding one. No symbols, formulæ, or equations are used at first, not, in fact, until the properties of three or four elements, and of some of their compounds, have been studied and the laws of chemical combination deduced from them. Then, and not till then, it is thought that a learner can appreciate the value of Dalton's atomic theory in accounting for the facts he has observed, and can see the advantage of a system of chemical shorthand, and use it with intelligence and discrimination."

LXIII. "The method, in my opinion, most likely to render the teaching effective as a mental discipline is mercilessly to sweep off a large proportion of the facts at present dealt with, to confine the attention of the pupil to those that for various reasons are the most important, and to use them always as illustrations of general laws. For this purpose there must be agreement among teachers and examiners. I do not think it beyond the scope of your inquiry to suggest that, to make chemistry or any natural science do all that it can do towards mental discipline, there must be an attempt to use it as a means of destroying the contempt which familiarity breeds in us all towards common things. Unless you can call forth the interest of your pupil, his admiration, even his reverential awe towards the mystery of Nature, you have perhaps done more harm than good."

LXIV. "Eternal analyses of simple salts and mixtures such as are required by examinations of the present day weary and worry the student, waste his valuable time, and throw away labour which in nearly every individual case would be most profitably spent in carefully studying and testing some important laws or principles of chemistry, and which would make the student's knowledge of the subject thorough and personal. Chemistry is essentially an experimental science. The great value of the study of the whole subject lies in the practical work done and in the method of building the theoretical structure on the practical knowledge. It is therefore absolutely necessary to have a thoroughly good laboratory with a lecture-room attached, so that collective and individual work may be carried on with equal facility. At the present time, in our schools and colleges there is too much working for examinations, and the requirements to pass such examinations are as narrow as paper legislation can make them. The student is for ever testing mixtures or performing some exceedingly simple gravimetric analyses. He is tied down, has his knowledge fettered instead of having it expanded, and never reaches the more advanced and useful principles of chemical science, which he can only dream of from the hearsay of his text-book."

LXV. "There is no scale of value of the different parts of chemistry; there is no recognised system as to which should be taught first. I have known boys obtain scholarships simply because their teacher had been recently a pupil of their examiner and knew the kind of questions he was likely to set. The ordinary text-books, lectures, and practical work do but little for even the hardest worker. We want an authorised code of work issued by a consensus of the highest authorities."

LXVI. "I object strongly to boys in a laboratory being allowed to mix different solutions in test-tubes, day after day, to find out whether precipitates are formed or not. I have a high opinion of the advantages derivable from the teaching of chemistry when none of the harder parts are shirked, as a valuable mental discipline, and as giving, with drawing, the best means of teaching an ordinary boy the use of his hands as well as his head."

LXVII. "The result of the absence of practice in

quantitative experiments is to create an unnatural breach in the minds of pupils between the actual phenomena of chemical action and the theories by which such phenomena are to be explained. It might be found possible to treat the subject more logically if some attempt were made to teach the facts in a more natural order. The historical sequence by which the science has attained its present proportions might form the basis of a rational arrangement of the parts of the subject. In this way, by placing the pupils in the attitude of mind of original discoverers, the logical necessity of theories to account for the facts would give them more real meaning and interest. I am not acquainted with a text-book suitable for school use in which such an order is followed."

LXVIII. "Boys have been lectured to as if they were students, thereby producing a condition of things described by some writer as the perfect paradise of a boys' school, where the masters learnt the lessons and the boys heard them. Chemistry should be taught as everything else is taught—by making the boys do the work themselves; and the lesson should be a system of question and answer."

LXIX. "The calculation of chemical quantities, involving atomic weights, ought to come quite late in the course, so that the atomic theory is kept in the background at first. The pupil should make several experiments on the diffusion of gases and liquids which will lead up to the idea of molecules. I must say that I think that 'equivalents' should be used for some time before any reference is made to atomic weights. As to cramming a boy in the methods of writing equations, and finding how much sulphuric acid and zinc will make so much hydrogen, I can only say that, as the boy never attempts to carry it out in practice, and that if he did he would find his calculations all wrong as compared with his results, he had better leave them until late in his course, for their symbolic value and, in many cases, real worthlessness can only be estimated by a worker in quantitative analysis. I think a boy's practical work should undergo great alteration. At present he is examined in 'simple salts,' so of course he is prepared for that by a system of 'test-tubing' which teaches him very little. He ought to start as far as possible with elements which he knows, such as sulphur and iron, and he should prepare certain compounds which contain them. He should then study the action of metals on acids, and the salts formed; cases of oxidation and reduction; preparation and properties of gaseous elements and compounds."

LXX. "In order that chemistry may be a useful subject for the education of boys, it seems to me necessary that it should be taught from experiments involving measurements. Other experiments may be amusing, but do not appear to afford food for severe or productive thought. It seems to be now generally admitted that boys should be led as far as possible to make inferences from chemical experiments for themselves. If they are to be taught the principal facts of chemistry in this way, it follows that the experiments must be of the former nature. It seems to be an evil that so much importance is attached in many examinations to qualitative analysis, which appears, from an educational point of view, to be one of the least valuable parts of the subject. The result is that teachers are compelled to spend the time given to laboratory work on this, to the detriment of experiments of a more instructive kind."

LXXI. "For beginners, the illustrated lecture, well supplemented by periodical questioning, examination of note-books, &c., seems the only feasible way of teaching large classes of, say, thirty or forty. When the class is very small the lecture can be largely replaced by laboratory work, in which the experiments are performed by each individual student. This seems to me the best method; but my experience is that it is impossible to satisfactorily conduct *large classes* of *young* boys in the laboratory, except in such simple experiments as the action of metals on acids, which can be done with a few test-tubes and other very simple and inexpensive apparatus, the breakages being too serious in an ordinary school if it is attempted to go through the preparation of all the commoner gases with a large class of beginners in laboratories as they are usually arranged. I think more satisfactory results might be obtained with such classes if a part of the laboratory were specially arranged for the purpose, a bench (with only a few necessary reagents) in the form of a semi-circle being used, the students *facing* the teacher, who would stand inside the semi-circle. In such a class the students would all perform the same experiment after being shown it by the teacher. With rather more advanced students I think the separate system is better, all students not working at the same experiment, as this obviates the necessity of providing a large number of pieces of apparatus of the same kind, and allows a quicker student to make more rapid progress. I think it is very important that quantitative experiments should be made as early as possible; but here again my experience is that young beginners cannot be trusted with balances sufficiently delicate to be of much value. The stereotyped 'test-tubing' course examination of simple salts and mixtures is certainly a very inadequate laboratory course taken by itself; but it has, I believe, its advantages for school purposes in teaching care, order, and cleanliness, and it serves well for the middle classes of the school if properly supplemented by class-teaching, in which the chemical actions concerned in the testing are carefully considered."

LXXII. "Chemistry cannot properly be taught apart from Physics; there is a physical side to every chemical phenomenon. Lecture work should precede laboratory work, and continue *pari passu* with it. Analysis rationally (not mechanically) taught is an excellent mental training. The two should be closely correlated; exercises should be given in the laboratory preparatory to or suggested by the subjects treated in the lectures, and facts learnt in the laboratory should be turned to account in the lectures. The teacher must not be trammelled by text-books: these must be his instruments, not his masters. Quantitative treatment of subjects in the lectures should be introduced as far as possible from the first, and as pupils advance they should be trained individually in the use of the balance. Numerical exercises based on (not as a substitute for) lecture demonstration help to give fixity and precision to ideas. Pupils should be trained to think out in their note-books the connection between experimental demonstration and theory, and not have notes dictated to them to be committed to memory. Their knowledge should be tested by frequent short examination papers."

LXXIII. "With regard to the practical work in the laboratory, the value of which cannot be over-estimated as a means of bringing a boy into real touch with his book-work and developing in him those valuable qualities of patience, accurate observation, and powers of deduction, so especially necessary to the student of science, analyses of complicated mixtures not found anywhere in the universe are no longer now considered as the object to be aimed at. But there is still too much tendency to regard mere analysis as the aim and object of laboratory work. Rather should a boy be introduced to a progressive course of work which illustrates the more important principles of chemistry, and so enable him to test the truth of these for himself. Here especially a good text-book of practical work is required, as a busy teacher finds it so difficult to get time to devise as well as supervise. Such a course of work must necessarily be limited in many schools owing to the want of sufficient apparatus or the short hours of work. But still something may be done in this direction, and the mental training will not only be of infinitely more value to the special student, but also to the ordinary boy, who will not be much the wiser for having gone through a course of simple and complex analysis only. I think your Committee might do much towards smoothing the path of teachers by drawing up a memorandum addressed to the head-masters of schools suggesting points for thei

consideration, and asking them to meet the Committee's views on the subject as far as lies in their power."

The Committee feel that these reports have put them into possession of the actual facts connected with the teaching of chemistry in schools, and have made it clear that something should be done in the direction of promoting a more uniform and satisfactory treatment of the subject. The Committee think that some suggestions might now be made as to the method of teaching chemistry which should be followed in schools. If this can be done it will certainly confer a great benefit on both teachers and examiners, and will be likely to lead to a more emphatic recognition of the merits of the science as an instrument of elementary education. The Committee accordingly ask for re-appointment.

NOTICES OF BOOKS.

Nineteenth Report of the State Board of Health of Massachusetts. Boston: Wright and Porter.

We find here some very interesting matter bearing upon the sewage question, which is by no means as near solution or as unimportant as certain sanitarians now wish us to believe.

We see it mentioned that "the Merrimack is a good instance of the ability of a large river to receive much polluting material in the form of sewage and manufacturing refuse without becoming seriously polluted. It has, in this respect, not only the advantage of large volume, but it is unusually well aërated by agitation in rapids, dams, and water-wheels, which, without doubt, have some influence in counteracting the influence of the organic matter."

The purification of sewage by applying it to land is next considered, the conclusion reached that, "desirable as the use of sewage in irrigation is, we cannot depend upon irrigation alone, in the more thickly settled parts of the State, for preventing the pollution of streams." Yet we should conclude that in America irrigation would act more advantageously than in the moister climate of Britain.

The author, with Schlœsing, Warington, and Frankland, ascribes the decomposition of the nitrogenous organic matter in soils to the presence of nitrifying organisms, and infers that filter-beds, of proper material, can purify ten to twelve times as much sewage per acre as can be applied to our farm-lands in irrigation.

Some very interesting experiments have been conducted at Lawrence. The respective mediums used were coarse clean mortar-sand, fine white sand, peat, river-silt, garden soil, soil superimposed upon sandy loam, sand and gravel, and, lastly, compact clay, sand, and gravel covered with garden soil. Peat is found "of little value as a filtering material," the organic matter being "more than doubled." Coarse sand, on the contrary, reduced the organic matter to one-half, the free ammonia and the albumenoid ammonia each to one-fourth, and the nitrates to three-fourths of the amounts in the applied water.

We are here compelled to ask, What has become of the albumenoid ammonia if it reappears neither as free ammonia nor as nitrates? With fine sand we have also a simultaneous reduction of organic matter, of free ammonia, albumenoid ammonia, and nitrates.

The number of bacteria found in 1 c.c. of the sewage filtered was 193,000. In the effluent from the fine sand there were, on January 3rd, 6680; and on January 5th over 10,000. Some of the species in the effluent were identical with those in the sewage.

We may remark that, had these experiments been performed in summer, the results, from a bacteriological point of view, would have been more conclusive.

The Gas and Water Companies' Directory, 1888. Edited by C. W. Hastings. London: Hazell, Watson, and Viney.

This useful compilation addresses itself not to sanitary authorities, medical officers of health, &c., but to shareholders, debenture-holders, and to all who may have commercial relations with the companies or the bodies supplying gas or water.

The work shows, in parallel columns, the date of formation of the undertaking, date of special act (if any), total share capital paid up, dividends, loan capital; names of chairman, engineer, or manager, secretary, lessee, owner, or corporation; population, distance from London, and means of access.

The returns from gas undertakings are here more numerous than those from water-works.

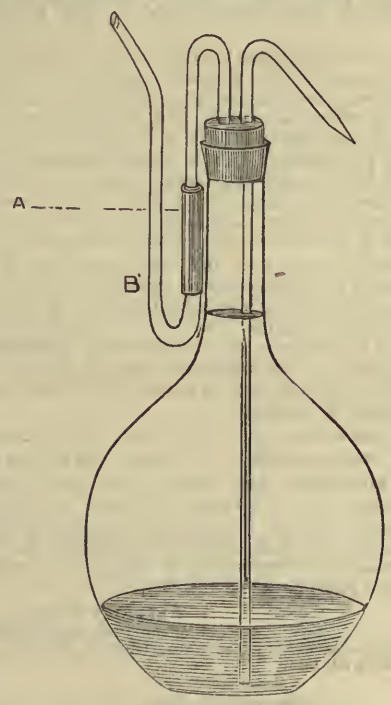
CORRESPONDENCE.

IMPROVED WASH-BOTTLE.

To the Editor of the Chemical News.

Sir,—I have used an improved wash-bottle which I think will be found useful to analytical chemists and others for washing precipitates, &c.

The annexed drawing is almost self-explanatory. After blowing with the mouth as usual until a good pressure has been obtained within the flask, the india-rubber tube



may be squeezed by the thumb against the neck, and then the mouth may be removed, but the water will continue to stream out of the jet. The tube B may be tied to the flask by string, and the neck of the flask wrapped with string or other bad conductor of heat.

When the bottle needs re-filling the india-rubber tubing, A, will stretch sufficiently to allow the withdrawal of the cork.—I am, &c.,

George W. Slatter,
Assoc.R.S.C.I., F.I.C., F.C.S.

ANALYSIS OF FERTILISERS.

To the Editor of the Chemical News.

Sir,—In the 1886 edition of Mr. Crookes's "Select Methods in Chemical Analysis" (p. 500) attention has been called to the fact of some analysts, in their examination of fertilisers, neglecting the rendering insoluble of the whole of the silica by bringing the acid solution of the phosphate to complete dryness prior to the separation of the lime; in consequence of which the siliceous matters other than actual sand, which are soluble in acids, are afterwards precipitated with the phosphoric acid and weighed as pyrophosphate of magnesia, thus yielding erroneously high results. Experimental evidence rendered by Mr. T. R. Ogilvie is given in support of the degree of error introduced, and as a result of his experiments it is shown that in some cases it amounts to a representation of 5 to 6 per cent more phosphate than the fertiliser contains.

Notwithstanding the publication of these facts it is much to be regretted that this erroneous system continues to prevail, to the detriment of those chemists carrying out the orthodox mode of complete separation. It is impossible for any chemist engaged in the analysis of fertilisers to thus carry out the letter of the chemical law without discovering the analysts alluded to in the handbook in consequence of the contradiction in results. I have before me the analysis of a fertiliser made by an eminent analyst in London in which he returned the total phosphates at 29·93, a result obtainable on neglecting the process described. The sample in question contained 25·40 per cent of actual phosphate of lime, but gave me by the co-precipitation of the silicates soluble in acid a result at 30.02·

The errors resulting from the non-separation of the whole of the siliceous matters—present in greater or less degree in all fertilisers—are not simply confined to the estimation of the total phosphoric acid, and appearing under the statement of insoluble phosphates, but they are likewise inherent in the determination of the phosphates rendered soluble. I have, during the present season, made several experiments on the determination of the soluble phosphoric acid in mineral superphosphates, with a view to ascertaining the degree of error occasioned by siliceous matters coming into solution with the acid phosphate of lime. The following few examples will serve for illustration, the lower percentages being the actual amount of phosphate of lime rendered soluble, present in each sample, the higher ones showing the erroneous results obtainable on neglecting to bring the water solution of the phosphate (with certain precautions) to complete dryness prior to the separation of the lime:—

No. 1.	24·04—25·01.	No. 3.	26·81—28·49.
No. 2.	24·80—27·36.	No. 4.	26·40—29·04.

As the erroneously high results have been issued by some chemists in their analyses of these phosphates by the magnesia method, it would appear as though they were under the delusion that acid phosphate of lime is the only substance dissolved in making up the water solution of the phosphate.—I am, &c.,

Alfred Firby,
Analyst for the Tadcaster Chamber of Agriculture, &c., &c.

Laboratory, 98, Albion St.,
Leeds, Sept. 28, 1888.

BLOWN OIL.

To the Editor of the Chemical News.

Sir,—Mr. Mullins seems to misunderstand the object of the work of mine from which he quotes. The book in question is entitled "Commercial Organic Analysis," and many chemists hold the opinion that it would have been better to have confined the subject-matter strictly to analytical methods, and left the composition and properties of the bodies treated of to take care of themselves. I have habitually restricted the description of manufacturing operations to mere outlines, or have relegated fuller descriptions to footnotes. To have given the working details of manufacturing operations would have required much space, and would have been of little use in many cases without drawings of the apparatus used. Such a course would have converted the book into one on manufacturing chemistry instead of chemical analysis, and would have still further delayed the completion of the work.—I am, &c.,

Alfred H. Allen.

101, Leadenhall Street, E.C.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 9, August 27, 1888.

This number contains no chemical memoirs.

No. 10, September 3, 1888.

In What Stage of Oxidation do Chrome and Manganese Exist in their Fluorescent Compounds?—Lecoq de Boisbaudran.—The author holds that rose-coloured fluorescent chromiferous alumina, prepared in hydrogen, cannot easily contain chromium in a stage of oxidation higher than Cr_2O_3.

Revue Universelle des Mines et de la Metallurgie. March, 1888.

This issue contains no chemical matter except a notice of certain Australian minerals, from the Chemical News, and an abridged account of Professor L. de Koninck's process for the determination of carbon in commercial irons. The ordinary method consists in the separation of the carbon by means of a solution of cupro-ammonium chloride, and a subsequent combustion of the carbon by the moist way. Without great care is taken in washing the carbonaceous residue, chlorine may be evolved along with carbonic acid. To avoid this error Professor de Koninck introduces into the combustion flask a little silver sulphate.

April, 1888.

Manganese-Steel.—This paper is chiefly devoted to the physical, and especially the mechanical properties of this alloy. The writer, with Bresson, now considers that steel should in future be defined, not as an iron carbide, but as "a peculiar state of iron, produced by the union of this metal with bodies whose nature may vary, such as carbon, manganese, chromium, tungsten, and silicon.

Qualitative Separation of Gold and Platinum from Arsenic, Antimony, and Tin.—Prof. de Koninck and Dr. A. Lecrenier.—The precipitate of sulphides, dry or moist, is heated in a current of hydrochloric acid gas, produced by the action of sulphuric acid upon ammonium chloride in fragments in an apparatus described by one of the authors in the *Zeitschrift fur Analytische Chemie* for 1880. The antimony and tin are quickly volatilised as chlorides, the arsenic sulphide is expelled unchanged, whilst gold and platinum remain behind.

Determination of Sodium Chloride in the Alkaline Waters of Coal Mines.—Prof. de Koninck.—The water to be examined is introduced into a flask marked at 200 c.c. and at 220 c.c. The water must extend to the first mark, and a solution of calcium nitrate is introduced up to the second mark. This solution must be of such a strength that the salt may be in excess with reference to the sodium carbonate. It is shaken up for a few moments

and filtered through a dry filter, 110 c.c. of the filtrate being collected. The calcium carbonate, in its precipitation, carries down the colouring-matters so that the filtrate is perfectly limpid and neutral. Of course the chloride can now be determined by means of a standard solution of silver nitrate, using potassium chromate as indicator. The result, multiplied by 10, shows the weight of sodium chloride contained in a litre of the water.

Determination of Manganese in Slightly Manganiferous Cast-Iron.—C. Reinhardt.—From 3 to 4 grms. of the metal are treated in a covered vessel with 30 to 40 c.c. of hydrochloric acid of sp. gr. 1·19. A little potassium chlorate is added. The reaction is at first let go on in the cold, and heat is then applied until the solution is completed. The liquid is then evaporated down to 15 to 20 c.c., an equal volume of cold water is added, and the whole is filtered. The filtrate is collected in a flask marked at 500 c.c.; 5 c.c. of nitric acid at sp. gr. 1·4 are added per grm. of metal, and the mixture is boiled until it takes a decided yellow colour. The solution is cooled; milk of oxide of zinc is added until the iron is precipitated, the flask is filled up to the mark, and the liquid is filtered through a dry filter. 250 c.c. of the filtrate are collected and the manganese is precipitated as dioxide with the aid of heat by means of sodium acetate, bromine, and zinc oxide. The precipitate is collected upon a filter, washed, dissolved in dilute sulphuric acid containing a known quantity of oxalic acid, the excess of which is finally determined by means of a standard solution of permanganate.

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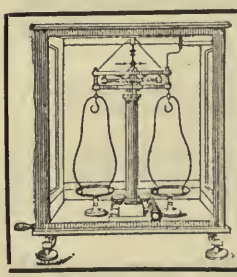

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1507.

ON THE INFLUENCE OF SULPHUR UPON EGGERTZ'S CARBON COLOUR-TEST.

By T. W. HOGG.

It is now pretty well known that Prof. Eggertz's simple process for the colorimetric determination of carbon in steel is open to many sources of error.

In the first place the colour intensity of a solution of steel in nitric acid of 1·2 sp. gr. does not depend entirely upon the quantity of carbon which may be present, but also so much upon its condition that in some special cases the results become quite misleading. Again, the colouring-matter which gives to the solution its peculiar tint is so extremely sensitive to external influences that serious errors occasionally arise from the neglect of certain necessary precautions. The other elements usually present in steel are generally supposed to be without any influence upon the colour-test, and, so far as I have been able to find, the only experiments bearing upon this point have been conducted by Prof. Eggertz himself, and an account of them may be found in the Chemical News, vol. xliv., p. 173.

Amongst the substances examined is the element sulphur, and in order to ascertain the influence of it, 0·001 grm. in the form of magnesium sulphate, was added to 0·1 grm. of iron dissolved in 2·5 c.c. of nitric acid and 2·5 c.c. water—"the sulphur was found to be without any influence."

It is quite evident, therefore, that the above conclusion rests entirely upon the assumption that the sulphur, which of course is present in the steel as a sulphide of iron, is oxidised to SO_3, and will be present in the solution as a sulphate.

From the fact that the quantity of sulphur usually present in steel is very small, and that it is exposed for a considerable time to the action of hot nitric acid, it may be very reasonable to make such an assumption, but that it is not quite the case anyone can soon satisfy himself by experimenting upon any special steel containing a considerable quantity of this element. The sulphur is really liberated as such, and remains suspended in the fluid, thereby communicating to it a certain turbidity or milkiness, particularly striking in the case of low carbon or "mild" steels. This peculiarity enables one to select from a miscellaneous lot of samples all that are likely to be abnormal in the proportion of sulphur.

Pure Swedish steels which contain mere traces of sulphur dissolve in nitric acid of 1·2 sp. gr., and after the usual twenty minutes heating in boiling water are always found to be perfectly clear and brilliant; common steels, in which the sulphur may reach, say, 0·05 per cent, give a solution so decidedly different in clearness that they can be readily distinguished from each other. More noticeable still does the influence of the sulphur become when it is present to the extent of 0·1 to 0·2 per cent, and in a "steel" with 0·50 per cent it is quite impossible to make any satisfactory adjustment of the tints.

In the experiment tried by Prof. Eggertz, and referred to above, the sulphur added as magnesium sulphate is equal to one per cent; if a "steel" actually containing this quantity had been used, instead of finding it to be without any influence, it would have been found quite impossible to compare it with any ordinary standard.

A very simple experiment showing how the colour estimation is influenced by the presence of suspended matter in the liquid, may be tried by taking a highly diluted solution of ammonium sulphide to which an excess of nitric acid has been added; this solution will be quite milky, owing to separated sulphur. If now a sample of pure Swedish steel be dissolved in the usual way and divided into two equal portions, and to one of them a drop of the above solution is added, an immediate increase in the colour intensity will be observed when the tubes are examined from above as they are held over a mirror.

Not only is the colour intensity altered, but the brilliant amber-coloured solution will be found to have acquired a distinctly browner hue, and this suggests that, apart from the difference of colour quality, due to slight variations in the condition of the carbon, sulphur also possesses an important influence in this respect.

Another interesting experiment is to take the solution of a common steel containing 0·05 to 0·1 per cent of sulphur and divide it into two equal portions and filter one of them; if they are now carefully compared with each other the result of the observation will be somewhat astonishing to those who may be under the impression that their estimamations are reliable to within one or two hundredths per cent; the two solutions will be different both in quality and intensity. I would here point out that when an attempt is made to adjust the tints of two coloured solutions differing slightly in clearness or quality, if only a small portion of the liquid be looked through, as is done when looking across the tubes, the observer is often easily satisfied with his comparison; but if after having apparently adjusted the tints of the liquids in this manner he will look through a much greater depth of the fluid, his self-satisfaction will often disappear; the fact is that two coloured solutions, differing even slightly in quality, can never be exactly equalised.

This subject is one of great importance on account of its bearing upon the question of the proper selection of standards, and in conclusion it may be of interest to note that if a common steel is compared with a standard of pure Swedish, the colour intensity is sure to be overestimated, and if the standard is of a common or impure steel the estimations in the purer samples will be too low.

The Laboratory,
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VOLUMETRIC ESTIMATION OF BORACIC ACID, AND OF AMMONIA IN AMMONIA SALTS.

By J. McGLASHAN.

The following is an account of some results obtained, using Poirrier's orange II. and orange III. as indicators, for the determination of boracic acid and ammonia in ammonia salts volumetrically.

In the first experiment with boracic acid four quantities of 2 grms. each were taken, dissolved in water, a few drops of the orange II. or orange III. solution added, and titrated with normal soda gave:—

With orange II. 99·6 and 99·8 per cent H_3BO_3
" " III. 99·8 " 99·8 " "

$NaBO_2$ being the salt neutral to both indicators.

In the next experiment 2 grms. of borax were taken for each determination, dissolved in water, and the boracic acid liberated by adding dilute sulphuric acid until neutral to methyl orange. A few drops of the orange II. or III. were then added, and standard soda run in until the yellow colour of the solution was changed to red.

Orange II. gave 38·3 and 38·4 per cent B_2O_3
" III. " 38·3 " 38·4 " "

estimating the Na_2O present in the borax, and calculating to B_2O_3, gave 38·38 per cent B_2O_3.

In estimating boracic acid in boracite or borate of lime, a weighed quantity of the mineral was heated in a flask with dilute sulphuric acid; when the decomposition was complete, caustic soda solution was added to the contents of the flask until neutral to methyl orange, and the insoluble calcium sulphate filtered off and washed. A few drops of orange II. or III. were then added to the filtrate, and the boracic acid titrated with normal soda.

Orange II. gave 45·6 and 45·5 per cent B_2O_3
„ III. „ 45·6 „ 45·7 „ „

This sample by analysis in the usual way gave 45·59 per cent B_2O_3.

In this experiment, if the caustic soda used in neutralising is not free from carbonate, the contents of the flask must be boiled either before or after filtering to get rid of any carbonic acid that may be in solution; otherwise it will be estimated as boracic acid.

The presence of ammonia in any form other than the hydrate or borate is to be avoided. If ammonium borate is the salt in which the boracic acid is to be estimated, it may be done by adding standard soda to the solution right away. Free ammonia in a dilute solution acting as if neutral to the oranges II. and III., the change in colour taking place when the soda is in excess, so, by adding a standard solution of soda to an ammonia salt, it is possible to estimate the ammonia without distillation; of course this is not applicable to a mixture of ammonia salts. In the case of commercial ammonia salts, any free acid they contain must be neutralised before proceeding to estimate the ammonia. Two grms. of pure ammonium chloride were taken in each of the following experiments:—

Orange II. gave 31·5, 31·4, and 31·5 per cent NH_3
„ III. „ 31·5, 31·5, „ 31·5 „ „

With ammonium carbonate the end reaction was indistinct, the sodium carbonate formed being slightly alkaline to both oranges. Titrating sulphuretted hydrogen with caustic soda, using oranges II. and III. as indicators, the end reaction was sharp; NaHS being the neutral salt. With arseniates, oranges II. and III. gave an indistinct end reaction. For the purpose of comparison it will be found convenient to keep a beaker alongside containing water with a few drops of the indicator or indicators added, and made alkaline with a drop or two of normal soda.

City Analyst's Laboratory,
156, Bath Street, Glasgow.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending August 31st, 1888.

By WILLIAM CROOKES, F.R.S.;
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To General A. De Courcy Scott, R.A.,
Water Examiner, Metropolis Water Act, 1871.

London, September 4th, 1888.

Sir,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from August 1st to August 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

As might have been expected, the unusual and irregular meteorological conditions of the past few months have had a certain influence on the waters of the Thames and Lea. We shall have to comment on this circumstance hereafter. We content ourselves now with remarking that the water supplied to London during a very exceptional summer, has been uniformly good and wholesome. Of the 182 samples examined by us during the month of August (excepting three samples of the East London Company's supply, which were recorded as "very slightly turbid"), the whole were found to be perfectly bright and free from any trace of suspended matter.

We are, Sir,
Your obedient Servants,
William Crookes.
William Odling.
C. Meymott Tidy.

RESORCINOL AS A TEST FOR NITRATES.*

By DAVID LINDO.

Reagents.

An aqueous solution of resorcinol, 100 c.c. contained 10 grms. of the phenol.

Solution of HCl about 15 per cent.

Pure concentrated sulphuric acid.

0·5 c.c. of nitrate solution taken for each test. 1 drop HCl, 1 drop resorcinol solution, and 2 c.c. sulphuric acid. Test-tubes $\frac{5}{8}$ inch employed. White back ground. Three or four tests made together at each dilution of N_2O_5.

N_2O_5 dilution.	Reaction.
1,000,000	Faint purple, not sufficiently definite be be reliable even after long standing.
500,000	After some time a definite purple. Colour permanent.
100,000	At first purple-red; after an hour pronounced purple. Takes several hours to develope fully. A beautiful colour and very permanent.
50,000	After some time purple colour very intense. Lower portion of band fine purple-red.
20,000	After some time colour so intense can only be distinctly seen in the upper portion of band by transmitted light.
10,000	Colour so intense can only be seen distinctly in the lower portion of band. Vivid purple-red.

Remarks.—Without HCl resorcinol is not of the least value as a test for nitrates; with the addition of HCl it is perhaps one of the best reagents we possess for the purpose. It is fully five times more delicate than carbolic acid, and the final purple colour which the bands acquire is very permanent. The blanks with distilled water, HCl, &c., show a faint compound band, pink above, yellow below; this cannot possibly be mistaken for the definite purple band which the test gives with N_2O_5, even at a dilution of 500,000. One drop copper solution (2 per cent sulphate) added to the test was found to increase the intensity of the band, but not to a very remarkable extent; the metal may therefore be dispensed with when this phenol is employed.

* For further details as to the method, which is the same as the author employed with other phenols in testing for nitrates, see Chemical News, vol. lviii., p. 1.

It would be premature to say that resorcinol is equal to the copper orcinol reagent as a test for nitrates, since the influence of other bodies on the reaction has not yet been studied. It appears to be a little more delicate for nitrous than for nitric acid; as a test for chlorates it is of little or no value.

Colour Reactions with Resorcinol and Oxidising Agents free from Nitrogen.

0·5 c.c. solution of the oxidising agent for each test, 1 drop resorcinol solution, 2 c.c. sulphuric acid. Tests made with and without addition of 1 drop HCl.

Potassic Chlorate.

1000 Cl_2O_5	Compound band orange top, intense blue soon changing to green below.
10,000 Cl_2O_5	The same, but much weaker.
With HCl	As above, but weaker.

Potassic Dichromate.

Half grm. to 1 litre of water.

Red to buff-coloured top band, purplish lower band. On standing purple changes to pink or ruddy brown with HCl. If the sulphuric is run in at once, buff top band, lower narrow brown band. If the test is left to stand until it turns green before adding sulphuric, then red top and green lower band, red soon fades.

These double bands cannot be mistaken for the permanent purple band which N_2O_5 gives with the test.

Permanganate.

N/10 with four volumes of water.

Dark orange top band, yellowish below.

With HCl, fine shaded compound band, orange-red top, greenish shade below.

Hydroxyl.

Solution sufficiently diluted gives green and brownish compound band.

Falmouth, Jamaica, B.W.I.,
September 10, 1888.

THE DISSEMINATION OF SULPHUR AND PHOSPHORUS AS OBSERVED BY ELECTRO-DISSOLUTION, AND COMBINED WITH THE SECONDARY EFFECTS OF ELECTROLYSIS.

H. N. WARREN, Research Analyst.

Whenever sulphur is caused to act upon metallic iron, under all ordinary circumstances there is produced the ordinary protosulphide of iron, of the formula FeS. Take, for instance, a pound of iron, in a liquid or molten form, into which a few grms. of sulphur have been introduced. Ordinary combination at once takes place. The product, after thorough incorporation has been attained, by either rotation or stirring, is for convenience sake obtained in the form of a rod by casting while still liquid, and afterwards attached to the positive pole of a compound battery, a platinum or thin copper plate being also attached to the negative, the whole being immersed in a dilute solution of $FeCl_2$. On the circuit being completed the casting becomes gradually dissolved, the metal depositing upon the negative plate, thus giving rise to free acid, which again reacts on a fresh quantity of iron, the action proceeding as before. On withdrawing the stick of iron from the solution after the lapse of a few hours a quantity of black granular precipitate may be readily detached, which, after drying, has the ordinary composition of ferrous sulphide, FeS, since no sulphuretted hydrogen has been evolved.

The theory of such a reaction would thus tend to show that the compound expressed by the formula FeS is the only combination obtainable by the simple action of sulphur on metallic iron, aided by heat, and that the sulphur does not disseminate itself throughout the whole mass of metal to form a compound possessing a formula where iron predominates largely, such as would be inferred from the formula expressed by Fe_8S, and which could be arrived at by calculating from analytical data; but exists rather in the form of sulphide of iron, disseminated, so to speak, through a mass of pure iron, the sulphide present forming a simple network allowing the current free passage; the iron being a much superior conductor of electricity than the sulphide, becomes more rapidly dissolved, leaving the residual sulphide.

The dissemination of sulphide of iron may be also readily observed by projecting sulphur on to the surface of molten iron, allowing the contents to solidify, and after cooling the same, dislodging the crust of sulphide of iron thus produced, leaving the iron below unaffected. But on repeating the experiment and thoroughly incorporating the same the sulphide formed in the first instance completely disseminates itself throughout the whole mass, leaving a more or less brittle regulus. Phosphorus may be entirely substituted for the sulphur in every instance, affording similar results, iron, nickel, cobalt, and all metals of the third group behaving more or less similar; the highest and most important phosphide of iron yet produced being apparently that represented by the formula Fe_4P, produced by the reduction of the phosphate at a high temperature in the presence of carbon. I have dissolved by the aid of electrolysis numerous prepared specimens of iron containing various percentages of phosphorus, the residues of which closely approach a formula of Fe_4P.

Percy, in his metallurgical treatise, describes several compounds of phosphorus with iron, to the lowest of which he attaches the formula $Fe_{12}P$. Considering then that Fe_4P is the highest obtainable phosphide, that expressed by $Fe_{12}P$ is entirely composed of Fe_4P disseminated through a larger bulk of iron, and may be again separated by electro-dissolution.

With respect to silicon, the highest silicide of iron that I have succeeded in obtaining would assume a formula expressed by that of Fe_2Si, while of carbon, according to Abel and Bloxam's treatise, the authors assert that iron never combines with more than six per cent of carbon, and they therefore represent the formula of carbide of iron by Fe_4C. Considering, then, that the above-mentioned elements exist when in combination with iron in the form of silicide, phosphide, sulphide, and carbide of iron, the following is a tabulated outline expressing the same result when calculated differently.

Result obtained by Ordinary Analysis of Sample Grey Cast-Iron of Excellent Quality.

Iron	94·946
Graphite	2·340
Manganese	2·370
Ni+Co	0·014
Li	0·230
Phosphorus	0·070
Sulphur	0·030
	100·000

Result as obtained in accordance with Various Electro-dissolutions.

Iron, Fe	93·443
FeS	0·083
Fe_4P	0·600
Fe_2Si	1·150
Mn	2·370
Graphite	2·340
Nickel and Colbalt	0·014
	100·000

On making a like observation regarding the metals of the second group, exactly a reverse phenomenon presents itself, for on introducing sulphur into molten copper no dissemination of the sulphide of copper thus produced is manifested, but results in a nucleus of pure copper, imbedded or surrounded by a wall of cupric sulphide, the same result being also obtained by a similar treatment of most metals of the second group. On again returning to this particular form of electrolysis, the secondary results that may be afforded thereby are often of more interest than the so-called primary results, the particulars of which must, however, for the present, be deferred to a further article.

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NOTE ON A NEW TEST FOR IRON.

By F. P. VENABLE.

A solution of cobalt nitrate to which strong hydrochloric acid has been added is blue. It was noticed that when some impure hydrochloric acid was used a green colour was gotten instead of the blue. This change was traced to the iron in the acid, and as I have seen no mention of it elsewhere, I venture to give the present notice of this test. It is very simple, rapid, and delicate for detecting traces of iron, and is especially useful in testing strong acids. The delicacy of the test is such that when even 3-100,000ths of a grm. of ferric salt are added to the blue strongly acid solution mentioned above, the green is clearly given. With a somewhat larger amount this green is quite vivid. If too much of the ferric solution is used the cobalt solution becomes pink from the addition of water. The test is not given by ferrous salts, nor does the presence of ferrous salts interfere with it. I have thought that the green was due to the addition of yellow ferric chloride to blue cobalt solution. Other yellow solutions which I have tested failed, however, to give the green.—*Journal of Analytical Chemistry*, Vol. i., Part 3, 1887.

THE USE OF COTTON AS A FILTER.

By A. B. CLEMENCE.

In the estimation of silicon in pig-irons, a large portion of the time is taken in filtering off the silicon and graphite, especially in irons rich in silicon. If a filter-pump is not at hand, and a filter paper only is used, three hours are often taken for filtering and washing a solution that contains 3 or 3·5 per cent of silicon, and even when a pump is used, in which case a support must be used, the filtering is often tedious.

Having had occasion some time since to estimate the silicon in a large number of samples of iron rich in silicon, I looked for a quick filtering material, and in cotton I believe I have found all that could be desired.

The method of analysis is the "Sulphuric Acid Method," with, perhaps, some slight modifications.

One grm. of the borings are placed in a 6" evaporating dish, and 40 c.c. of a mixture of 1 part concentrated sulphuric acid and 5 parts nitric acid of 1·20 sp. gr. are added. A watch-glass is placed on the dish and set on an iron plate heated by a 6-inch multiple burner.

The dish may be left without care until the iron is dissolved and evaporated till the ferric sulphate has spattered on to the watch-glass. Water is now added and boiled for two or three minutes, when it is ready to filter.

The filter is made as follows:—A 3-inch filter-paper is folded as usual and the apex cut off, leaving a hole about ⅛-inch in diameter; a wad of cotton (the absorbent cotton of the druggists) is pressed into the apex, and, when wet, may be, either with a pump or by the mouth, pressed tight enough to hold the residue. Even without a pump this filter will run so fast that close watching will be needed to keep the funnel full. Wash as usual with hot dilute hydrochloric acid and with hot water, when the residue, cotton and paper, is ready for the weighed crucible. Burning with a blast-lamp completes an estimation in forty minutes from the time of weighing the borings. The weight of the ash of the cotton will of course vary with the amount used, while that of the paper will be the same in each case, but it never need be more than 0·0005 grm., and this small amount may be disregarded when working on silicons for Bessemer charging. —*Journal of Analytical Chemistry*, Vol. i., Part 3, 1887.

THE STUDY OF MINERALOGY.*

By T. STERRY HUNT, LL.D., F.R.S.

1. Our knowledge of the inorganic kingdom, as seen in this earth, may be comprehended under geography, geology, and mineralogy; the latter in its wider sense including all non-organised forms of matter, with their whole dynamical† (physical) and chemical history. In didactic language, however, mineralogy is limited to the study of native species, and includes a knowledge alike of their external characters and their chemical relations. The so-called natural-history method in mineralogy, disregarding these latter, is based exclusively on specific gravity, hardness, optical characters, texture, and structure, including crystallisation; while the chemical method regards the results of chemical analysis alone, and mixed methods consider these in connection with crystallisation, and even endeavour to take into account other physical characters. The defects of all the methods hitherto devised are obvious, and no system of classification can be complete which does not assign a value and a place to all characters whatsoever. There exists in the nature of things such an interdependence of these that a true natural system can exclude none. To the establishment of such a system, a clearer view of the nature and relations of physical and chemical phenomena than that generally received will materially aid us.

2. Matter is susceptible of changes of volume of two kinds. (1). Those produced from without, by variations of temperature and of pressure, which changes are constant and regular. Effecting no essential alteration in species, they may be called *extrinsic* or, as the result of external dynamic agencies, *mechanical* changes. (2). Those which have been described as due to "internal disturbances," which effect specific alterations in character. These constitute *chemical* or what may be called *intrinsic* changes, and differ from the last in that, instead of being constant and regular, they are periodic and subordinated to definite and unforeseen relations of volume. Intrinsic changes of volume in matter connote chemical as distinguished from dynamical processes. In chemical union we have intrinsic contraction or condensation (variously designated as interpenetration, compenetration, identification, integration, unification); and in chemical decomposition, intrinsic expansion or division. These changes may be either

* Read before the British Association, Bath Meeting, Section B.

† We use the words dynamics and dynamical in the sense in which they are employed by Thomson and Tait in their treatise on "Natural Philosophy," wherein all those manifestations of force which are neither chemical nor vital (biotic), including, besides ordinary motion, the phenomena of sound, temperature, radiant energy, electricity, and magnetism, are embraced under the general title of dynamics, corresponding to what in popular language is designated physics. Other eminent students of our time have sanctioned this use of the term dynamics, in which they were to a certain extent anticipated by Berzelius, who in 1842 included electricity, magnetism, light, and heat—all of which he regarded as affections of matter, and compared their phenomena with those of sound—under the common term of dynamides. (See Hunt, "Mineral Physiology and Physiography," p. 13).

homogeneous, involving one species of matter, or heterogeneous, involving two or more species. The first includes so-called polymerisation and depolymerisation, which may be described as homogeneous intrinsic union and homogeneous intrinsic division; constituting what we have called collectively *chemical metamorphosis*. Those intrinsic changes which involve two or more species we have included under the title of *chemical metagenesis*; the process being one of heterogeneous intrinsic union or of heterogeneous intrinsic division. In the former, intrinsic contraction involves volumes of unlike species, and in the latter, intrinsic expansion resolves a species into two or more unlike species. The relations to volume of all such changes are most simple and evident in the case of gases and vapours; but the same laws of intrinsic contraction and expansion by volumes apply alike to gases and to the liquid and solid species formed by their condensation. In all of these chemical changes temperature and pressure play an important part, and beyond certain limits the extrinsic or dynamic changes thereby produced themselves provoke chemical changes. These in their turn are accompanied by thermic changes, the study of which is the object of thermo-chemistry.

3. All chemically stable forms of matter may theoretically, by sufficient elevation of temperature, assume, even under the greatest pressure, a gaseous condition; the more or less polymeric vapours thus produced being subject to intrinsic expansion or depolymerisation on diminution of pressure. By reduction of temperature these pass, as may be seen under favourable conditions, through successive polymerisations, or processes of intrinsic contraction, into liquid (or solid) species; the passage from the vapour to the liquid being apparently continuous. The ideal gas is wholly obedient to the dynamic influence of pressure, according to Boyle's law, to which the ideal solid is wholly indifferent. These ideal forms are, however, constant only within certain limited ranges of temperature and pressure, beyond which even the so-called permanent gases become liquid or solid by intrinsic changes.

The regularity of the extrinsic variations in volume for gases and vapours, within certain known limits, enables us for such bodies to determine their specific gravity, for which purpose atmospheric air at 0° and 760 m.m. is taken as unity. If for this we substitute hydrogen gas (represented as $H_2=2{\cdot}0$), the lightest body known, at the same temperature and pressure, the specific weight of an equal volume of any given vapour or gas, calculated for this standard temperature and pressure, is its equivalent weight, or in the language of the popular hypothesis, the molecular weight of the species. Extending the same method from normal gases and vapours to polymeric vapours, and thence to liquids and solids, and remembering that none of these forms are stable beyond certain ranges of temperature and pressure, we proceed to determine the specific gravity of all such bodies in terms of the same gaseous unit; the number thus obtained being for each body its equivalent weight. We thus find, as has long been suspected, that the equivalent (or so-called molecular) weights of liquid and solid species are exceedingly elevated. That of water, a litre of which at 100° (its temperature of formation under a pressure of 760 m.m.) weighs 958·78 grms., corresponds to 1192 volumes of water vapour at standard temperature and pressure ($H_2O=17{\cdot}96$) condensed into a single volume; or to $1192\times17{\cdot}96=21{,}408$, approximately 21,400. Representing by p the empirical equivalent weight, which is really the specific gravity on the hydrogen basis ($H_2=2{\cdot}0$), and by d the specific gravity taking water $=21{,}400$ as unity, we obtain by the formula $p\div d=v$, the reciprocal of the coefficient of the condensation which takes place in the passage of a normal gaseous species, by intrinsic contraction or polymerisation, into the liquid or solid species, the specific gravity of which we have determined by comparison with water.

4. The reciprocal number thus got is, as we shall show, one of great significance. In determining the specific weight of any given liquid or solid species, the fact of prime importance is not simply its specific gravity as compared with water, but the relation of the value thus determined to the equivalent weight, or, in other words, to its specific gravity on the hydrogen basis. It is not d, nor yet p, but the relation $p:d$, as expressed by v. In the case of volatile species the true value of p may be known, but for the comparison of fixed solids, as oxides, carbonates, and silicates, we deduce from the received formulæ an arbitrary value for p by dividing the value calculated therefrom by twice the number of oxygen portions. Thus for MgO, $p=40\div2$; for SiO_2, $p=60\div4$; for Al_2O_3, $p=102\div6$; for $SiMg_2O_4$, $p=140\div8$; for $CCaO_3$, $p=100\div6$. For metalline minerals, including metals, and their compounds with S, Se, Te, As, Sb, Bi, the value assumed for p is that got by dividing the empirical equivalent weight by the sum of the valencies.

While the specific gravity of liquid and solid species is represented by d, the hardness, infusibility, and insolubility or resistance to chemical change are, for related species, directly as the condensation, or inversely as the value of v. This may be seen in comparing colourless ordinary phosphorus, $v=17{\cdot}2$, with the metalloidal form, $v=13{\cdot}2$; the isomeric silicates, meionite, $v=6{\cdot}5$, and zoisite, $v=5{\cdot}3$; or calcite, $v=6{\cdot}2$, with dolomite, chalybite, and diallogite, $v=5{\cdot}2$, and with magnesite and smithsonite, $v=4{\cdot}7$; for aragonite, $v=5{\cdot}55$. These examples will serve to show the relations between sensible characters and chemical constitution, the interdependence of which must be taken into account in a natural system of mineralogical classification. The differences in hardness and in solubility of the different species just named are familiar to chemists. The behaviour of native silicates with fluorhydric acid, lately studied by J. B. Mackintosh, illustrates in a striking manner the relations between condensation and solubility.

5. The successive forms imposed upon matter give us the order in which such a system of mineralogy should be built up. First, the form which we may call the *chemical form* of the species, either elemental or compound, due to the unknown stochiogenic process, or to subsequent chemical metagenesis. Second, what may be called the *mineralogical form*, which involves the greater or less intrinsic contraction (polymeric condensation) of the normal chemical species—often gaseous or volatile, but frequently unknown to us—and the assumption by it of a liquid or solid state, having greater or less specific gravity, hardness, fixity, and insolubility, and being metallic or non-metallic, colloidal or crystalline. Third, the *crystalline form*, being the geometric shape assumed by the crystalline individual, which connotes a certain structure, apparent in the cleavage, the varying hardness, and the thermic, optical, and electrical relations of the crystal, but is, notwithstanding its value in determinative mineralogy, the least essential or most accidental form of the mineral species. The significance involved in the note of metallicity is very apparent when we consider the metallic and non-metallic conditions of selenium and of phosphorus, the similar dual conditions of the sulphides of mercury and antimony, the non-metallic and sparry characters of the native sulphides of zinc, cadmium, and arsenic, and the singular metallic character assumed by the complex tungstates or Tungstometalloids, known as tungsten bronzes. These, with the not less remarkably complex soluble tungstates or Tungstosaniloids. and the native tungstic species, make the Tungstates one of the most instructive orders known.

6. The author has elsewhere proposed to divide the mineral kingdom into four classes, including (1) Metalline, (2) Oxidised, (3) Haloid, (4) Pyricaustate (combustible or fire-making) species. Each of these classes is again divided into orders, tribes, genera, and species. In the first class a single order includes two sub-orders and nine tribes, named (1) Metalloideæ; (2) Galenoideæ, including three sub-tribes, corresponding to sulphur, selenium, and tellurium compounds; (3) Bournonoideæ;

(4) Pyritoideæ; (5) Smaltoideæ; (6) Arsenopyritoideæ; (7) Spatometalloideæ; (8) Sphaleroideæ; (9) Proustoideæ; each tribe including one or more genera. Again, in the second class are grouped, under different orders, Oxides, Silicates, Carbonates, Borates, Sulphates, Phosphates, Tungstates, &c. Three sub-orders of silicates include protoxide, protoperoxide, and peroxide silicates; among peroxide bases being reckoned aluminic, ferric, manganic, chromic, bismuthic, and also, for special reasons, zirconic oxide. Recognising in each sub-order various types designated Hydrospathoid, Spathoid, Adamantoid or gem-like, Phylloid or micaceous, and Porodic or colloidal; the tribes may be named Pectolitoid, Willemoid, Amphiboloid, Talcoid, Ophitoid, Zeolitoid, Felspathoid, Granatoid (garnet-like), Micoid, Pinitoid, Perzeolitoid, Eulytoid, Topazoid, Pyrophylloid, and Argilloid. Soluble saline species in any order are referred to a salinoid type, as Borosalinoid, Tungstosalinoid. The extension of this system to the Haloid and Pyricaustate classes is easy, and has been elsewhere explained.

The work of arranging in genera and species, with a Latin binomial nomenclature, and the determination for each species of the value of v, is now nearly completed for the first two classes; and the whole will probably soon appear, with a proper introduction, as a Systematic Mineralogy, to be followed by a Descriptive Mineralogy. The general principles here set forth are discussed at length in the author's "Mineral Physiology and Physiography" (Boston, 1886), pp. 279 to 401, where, in a chapter entitled "A Natural System in Mineralogy," will be found an examination of the constitution and relations of the known natural silicates arranged in tribes, and tabulated, with the calculated values of v, and a new quantivalent chemical notation. See further, a paper on "The Classification and Nomenclature of Metalline Minerals,"* discussing Class I., in the *Proceedings of the American Philosophical Society* for May 4, 1888, reprinted in the Chemical News of August 10 and 17; also the author's "New Basis for Chemistry," 2nd edition (Boston, 1888), where, in Chapters VII. and XIV., many points in the proposed mineralogical classification are elucidated.

MINERALOGICAL EVOLUTION.†

By T. STERRY HUNT, LL.D., F.R.S.

In a paper read by the author in 1887, before the Geological Section of the British Association for the Advancement of Science, on "The Elements of Primary Geology," it was said that "the transformation of the primitive igneous material of the earth's crust through the action of air and water, aided by internal heat, presents a mineralogical evolution not less regular, constant, and definite in its results than the evolution apparent in the organic kingdoms."‡ The details of this complex evolutionary process, as explained by what the writer has named the crenitic hypothesis, have been elsewhere set forth at length, on more than one occasion, and involve the whole chemical history of the various mineral species which enter into the constitution of rock-masses, but especially their relations to subterranean changes under the influence of heated water, and to atmospheric action. As we have pointed out, the transformation of basalt into the hydrous porodic body known as palagonite, and the subsequent partial conversion of this into a crystalline zeolite, as described by Bunsen, furnishes a significant illustration of the process under consideration.

The stability of silicated species under atmospheric influences is very variable, some being readily decomposed, and others very permanent; the indifference or chemical resistance, moreover, increasing with the hardness or mechanical resistance. These two qualities vary for species of analogous constitution directly as their condensation; while for species of similar condensation and hardness the chemical indifference increases as alumina takes the place of the ordinary protoxide bases, lime, magnesia, ferrous oxide, and alkalies—a fact readily explained by the comparative insolubility of alumina and aluminous silicates in atmospheric waters. The less partial action of dilute fluorhydric acid on the various silicates shows more clearly than the atmospheric process the relation of condensation to chemical indifference. This relation may be made evident by a few examples. The condensation being inversely as the so-called atomic volume, we find that when calculated by a simple formula (elsewhere given by the author) for all silicates and oxides this value (represented by v ($=p \div d$) for the various felspars and scapolites, for nephelite, iolite, and petalite, equals $6{\cdot}8-6{\cdot}2$; for the muscovitic or non-magnesian micas, $5{\cdot}9-5{\cdot}6$; for garnet, epidote, zoisite, and the various tourmalines, $5{\cdot}4-5{\cdot}3$; for staurolite and spodumene, $4{\cdot}9$; and for andalusite, topaz, fibrolite, and cyanite, $5{\cdot}0-4{\cdot}5$, approximately. Comparing with these the common protoxide silicates, we find for wollastonite and willemite, $v=6{\cdot}6$; for amphibole, $5{\cdot}9$; for pyroxene and enstatite, $5{\cdot}5$; for chrysolite, $5{\cdot}4-5{\cdot}3$; and for phenakite, $4{\cdot}6$. In the sub-aërial decay of crystalline rocks, while felspars and scapolites among aluminiferous silicates are kaolinised, the micas, notwithstanding their laminated structure, are much less readily changed; and garnet, epidote, tourmaline, andalusite, and topaz are found unaltered with the quartz, corundum, spinel, cassiterite, and magnetite left behind by the decay of the felspathic rocks, —a process in which even amphibole, pyroxene, and chrysolite share. "The greater stability of those [silicates] which belong to the more condensed types is shown in their superior resistance to decay, and is thus of geological significance.

While the above are examples of the varying resistance to the atmospheric influences of carbon dioxide and water combined, other changes less well known take place in silicates by the subterranean action of watery solutions, where a greater insolubility determines the formation of certain softer hydrated magnesian and aluminous species by epigenesis from harder and more condensed species. The production of these epigenic products, as was said in 1885. is due to their "chemical stability under the circumstances," and it was added, "The constancy in composition and the wide distribution of pinite show that it is a compound readily formed and of great stability. Such being its character, it might be expected to occur as a frequent product of the aqueous changes of other and less stable silicates. It is met with in veinstones in the shape of crystals of nephelite, iodite, scapolite, felspars, and spodumene, from each of which it is supposed to have been formed by epigenesis. Its frequent occurrence as an epigenic product is one of the many examples to be met with in the mineral kingdom of the law of "the survival of the fittest." It is, however, difficult to assign such an origin to beds of this [described as dysyntribite and parophite], which are probably the results of original deposition or of diagenesis."

Mr. E. A. Ridsdale, who during the present year (1888) has done good service by publishing a suggestive essay called "Notes on Inorganic Evolution," speaks of the production and conservation of more stable species, as above described, as a gradual "selection of inert forms," and further, as "a survival of the most inert." But as inertness consists in stability, and in fitness to resist alike the chemical and the mechanical agencies which destroy other species, it is evident that his phraseology is but another statement of the formula of "the survival of the fittest."

The great principle of the change of the mineral matter

* An abstract of this paper, printed in the programme of the Royal Society of Canada, without revision or correction by the author, will also be found in the Chemical News for June 29, 1888.

† Read before the British Association, Bath Meeting, Section C.

‡ *Trans. Brit. Assoc.*, 1887, p. 704; also *Geological Magazine*, November, 1887.

which existed in former conditions of our planet, into other forms more stable under the altered conditions of later ages, is but an extension to the mineral kingdom of the laws already recognised in astronomical and biological development. As was written in 1884, "That a great law presided over the development of the crystalline rocks was, from the first, my conviction, but until the confusion which a belief in the miracles of metamorphism, metasomatism, and vulcanism had introduced into geology had been dispelled, the discovery of such a law was impossible." To this we may add that "the great successive groups of stratiform crystalline rocks mark necessary stages in the mineralogical evolution of the planet"; and that the principles which we have elsewhere laid down will help us "to recognise the existence and the necessity of an ordinary lithological development in time." The reader who desires to follow the questions here raised will find them discussed in the author's "Mineral Physiology and Physiography" (Boston, 1886), at much length in Chapters V., VI., VII., and VIII., and further noticed in the Appendix, p. 688, where will be found references to previous pages here cited.

NOTICES OF BOOKS.

The Analyst's Laboratory Companion. By Alfred E Johnson, Assoc. R.C.Sc.I., F.I.C., F.C.S. London J. and A. Churchill.

In taking up this book we feared it might prove to be one of the numerous abridged manuals of analysis, qualitative or quantitative. Such is not the case; the author, who evidently addresses himself chiefly to public analysts, takes a less over-crowded track. We find, first, a notice on the precipitating powers of ammonium oxalate, barium chloride, sodium phosphate, and magnesia mixture. Then follow notes and indicators, a table of symbols and atomic weights (where we still find platinum figuring higher than gold), a table of formulæ, molecular weights and percentage compositions of commonly occurring compounds, a table of the molecular weights and weight of one litre of various gases, and a list of multipliers and their logarithms required in gravimetric analysis. It may here be asked whether such tables as those appended to Rose's "Quantitative Analysis" are not much preferable to this method?

Then follow multipliers required in volumetric analysis, notes on logarithms, and a table of logarithms from 1 to 1000.

Next the author gives weights and measures both on the English and the metric systems, and tables for their mutual conversion. Here, however, as in most works, there is no mention of the mutual relation of the c.c. and the grain measure.

Next we find tables "required in water analysis," evidently on the Frankland and Armstrong principle; tables of hardness in water; Sprengel's method for determining nitrates in water; tables for gas analysis, for the examination of beer, for the determination of phosphates, and for the conversion of nitrogen into ammonia and albumenoids.

As a novelty we notice a method for the quantitative determination of chicory in "coffee as in France." Then follow tables for Baumé's hydrometer; an alcohol table; tables of the actual quantities of the ordinary acids and alkalies existing in solutions of different specific gravities, and comparative thermometric tables.

Report of the Commissioner of Agriculture, 1887. Washington: Government Printing Office.

The report of the chemist to the department is an extensive document, in which there are complaints, apparently well-founded, that the laboratory accommodation is meagre and the number of assistants insufficient. "In a dingy basement, poorly lighted, not ventilated at all, the chemists of this division are compelled to work, in the winter straining their eyes in an all-day twilight, and in summer sweltering in a tropical temperature." The chemist to the department very justly holds that the analysis of ores, mineral waters, and other substances foreign to agricultural research, should not be required.

The report treats upon American beers, wines, ciders, and their adulteration. Strictly speaking, it might be contended that if fermented liquors are to be regarded as agricultural produce, so likewise should paper, leather, woollen or cotton cloth, &c. The use of brass taps and lead pipes in drawing beer is condemned as introducing appreciable quantities of zinc, lead, and copper. It is remarked that in wine fermentation at 15°—20° gives a product richer in alcohol but poorer in bouquet than if the temperature had been kept at 5°—15°. Only one sample of American wine has been found fraudulently coloured, the dye used being magenta. One sample of cider was heavily adulterated with sodium hydrocarbonate and with a sulphite.

The development of the sorghum sugar-industry has for a time been checked by a patent obtained by a former employé of the department.

It is contended that as the process in question was developed by this person at public expense, and whilst he was a paid servant of the nation, the process must belong to the nation.

The prickly pear plant with its thorns scorched off has come into use as a food for cattle, and is found to be very nutritious.

Annual Report of the Board of Regents of the Smithsonian Institution: Showing the Operations, Expenditures, and Condition of the Institution to July, 1885. Part II. Washington: Government Printing Office.

This publication, which appears nearly three years after date, comprises the reports of the Assistant Director, and of the Curators and Acting Curator.

The largest portion of the volume is devoted to an account of the "Catlin" Indian Gallery, which is now deposited in the National Museum attached to the Smithsonian Institution.

The book gives evidence of intense and most honourable activity in various departments of science, though we find no matter which falls within the scope of the Chemical News.

The Chemical Analysis of Iron. A Complete Account of all the best known Methods for the Analysis of Iron, Steel, Pig-Iron, Iron Ore, Limestone, Slag, Clay, Sand, Coal, Coke, and Furnace and Producer Gases. By A. A. Blair, Chief Chemist United States Board Appointed to Test Iron, Steel, and other Metals; Chief Chemist United States Geological Survey and Tenth Census. Philadelphia: J. B. Lippincott and Co.

The author of this work informs us that his object has been to present within the compass of a single volume all the methods of real value to the iron-analyst. His work pre-supposes "some knowledge of general and analytical chemistry, and some practical experience in laboratory work and manipulation." He hopes thus to "facilitate in some cases the work of iron-chemists, to whom often very little is given, and of whom very much is required," a position, we must add, by no means unique.

Under the head "Methods for the Analysis of Pig-iron, Bar-iron, and Steel" we find directions for the determination of sulphur (including a "rapid" method), of silicon (also with a "rapid" method), of slag and oxides, of phosphorus (with a "rapid" method), of manganese, carbon, graphitic carbon, combined carbon, titanium, copper, nickel and cobalt, chromium and aluminium, arsenic, antimony, tin, tungsten, and vanadium. The "rapid method for sulphur is a volumetric determination

by iodine; that for silicon has been specially elaborated by Mr. S. Ford for this work, and is said to effect the determination of silicon, with an accuracy sufficient for all practical purposes, "in twelve minutes from the time the ladle is put into the molten iron."

The iron is first granulated by pouring into cold water, when the very appearance of the globules gives a clue to the proportion of silicon. If this impurity is abundant the drops will be almost globular, concave on the upper surface, and from ¼ to ⅜ inch in diameter. If little silicon is present, as in spiegel and ferro-manganese, the globules will be elongated with tails about ¼ inch in length. The globules are dried in the hot ladle, crushed in a steel mortar, sifted with a fine sieve, and 0·5 grm. of the fine siftings are put in a platinum capsule with 10 c.c. of hydrochloric acid at sp. gr. 1·2, covered with a watch-glass placed over a flame, and the iron dissolved. When this is effected the watch-glass is removed, and the solution evaporated to dryness as rapidly as possible over an open flame. When dry, dilute hydrochloric acid is poured upon the iron chloride, and, as soon as all is dissolved, water is added; the contents of the capsule are poured upon a filter to which is attached a pump, filtered and washed. The filter and contents are placed in a tared platinum crucible, placed over a blast-lamp. As soon as the paper is burnt the crucible is laid on one side, the lid removed, so a small jet of oxygen is driven very gently into the crucible. As soon as the carbon is burnt the crucible is let cool and weighed; so the silicon originally present is calculated from the silica remaining in the crucible.

The "rapid" method for phosphorus is indirect, turning on the estimation of molybdic acid in ammonium molybdo-phosphates.

The author next gives methods for the analysis of iron ores. Here, in his directions for sampling, he directs that 2lbs. should be taken for every 10 tons of the lot.

In the determination of total iron we are reminded that the residue insoluble in hydrochloric acid may still contain iron. Methods are given for bringing such refractory portions into solution.

In gas-analysis, which is considered at some length, Hempel's apparatus is recommended as generally preferable.

This work may, in fine, be pronounced a useful summary of a special and important department of analytical chemistry by an author of prolonged and wide practical experience.

Twenty-fourth Annual Report of the Alumni Association, with the Exercises of the 67th Commencement of the Philadelphia College of Pharmacy. For the year 1887-8. Philadelphia.

We cannot find in this Report any chemical matter save a Synopsis of a Lecture on "Milk, its Composition and Analysis," by Prof. H. Trimke. Here we find the very just remark "that the way *not* to judge of the quality of milk is by means of the lactometer." Valuable matter which does not come within our scope—pharmaceutical, dietetic, and physiological papers—is not wanting.

Guide-Book for Distillers and Manufacturers of Arrack, Cognac, Gin, Rum, Cordials, Liqueurs, &c., &c. By E. Sachose and Co., Leipzig, Distillers of Warranted Pure Essential Oils and Essences.

This pamphlet, which is accompanied with a wholesale price-list, and has evidently been not merely printed but drawn up in Germany, reminds us occasionally of "English as she is spoke." Witness such expressions as "carmin-surrogate," saffran "surrogate, "esmerald green," "oil of roses virrigin," "estragon," &c., which are assuredly not idiomatic English.

A much more important matter is the cross light which is here thrown into the recesses of the wine and spirit trade. We find receipts for manufacturing claret, Hungarian wines (dry or sweet), Madeira, Malaga, Muscat Lunel, port, hock, sherry, and Tokay!

As a specimen we quote the formula for sherry:—To make up 63 gallons the operator is to take 3 lbs. essence for sherry, 5 lbs. honey, 4 pints sugar, syrup 7 gallons, 5 pints plain white wine, and 7 pints of superior wine-spirit 56 over proof.

Lest the spirit-drinker should rejoice he will find that in concocting spirits and liqueurs "the best quality only of rectified spirit of potatoes (!) is to be used." The sugar to be used, both in wines and spirits, must not be "blued." In other words, the compounder must reject all sugars to which ultramarine has been added,—a trick not uncommon among the manufacturers of beet-sugar. Possibly we must be thankful that saccharine is not prescribed.

CORRESPONDENCE.

IMPROVED WASH-BOTTLE.

To the Editor of the Chemical News.

Sir,—The aphorism of the wise man of old that "there is nothing new under the sun" seems to be remarkably true as applied to wash-bottles. In January, 1881, I devised a new form of wash-bottle for producing a continuous jet for some time after ceasing to blow, and as it was generally approved I wrote a short account of the method of making it, and published it in the Chemical News of October, 28, 1881. Messrs. Becker and Co., of Maiden Lane, London, then took it up, and have made and sold wash-bottles of my pattern ever since.

I was not destined, however, to have the credit all to myself of having devised a new form of wash-bottle, as Mr. M. H. Foye, in the Chemical News of December 23, 1881, mentioned that he had contrived, about three years previously, a form of wash-bottle very similar to mine, the difference being principally that in his form the valve was on the *top* of the cork, while in mine it was at the *side*.

I was much amused, therefore, on looking through the Chemical News of last Friday to see my own form of wash-bottle exactly figured and claimed as a new device by Mr. Slatter. My original description was unaccompanied by a wood-cut, but from it any one can easily make a bottle for himself, as Messrs. Becker did originally.

The Royal College of Science, Dublin, has been peculiarly fertile in inventors of new forms of wash-bottles, three of us to my knowledge having brought out, no doubt independently, more or less new forms. That field, I think, is now virtually exhausted, and we must determine henceforth to go further afield in order to exercise our inventive powers withal.—I am, &c.,

Alfred E. Johnson,
Assoc.R.C.Sc.I., F.I.C., F.C.S.

10, Victoria St., Wolverhampton,
October 9, 1888.

ANALYSIS OF NATURAL SILICATES.

To the Editor of the Chemical News.

Sir,—I should be obliged if some one would kindly inform me where I can find a description of the method for the quantitative separation of the minerals composing natural silicates.

I presume that acids are used in the first instance, and that the insoluble matter is in some way separately treated.

How, for instance, should basalts or schists be analysed so as to gain the fullest information about them?—I am, &c.,

E. Dickson.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 11, September 10, 1888.

In What Stage of Oxidation do Chrome and Manganese Exist in their Fluorescent Compounds?—Lecoq de Boisbaudran.—In this lengthy paper the author seeks to show that in the ruby chromium must exist in the state of sesquioxide.

On the Indium Chlorides.—L. F. Nilson and Otto Petterson.—The authors have obtained three distinct chlorides stable in the gaseous state. These are a trichloride, $InCl_3$, a dichloride, $InCl_2$, and a monochloride, InCl. It thus appears that a metal of the third group of the natural system of the elements may act as mono-, di-, and tri-valent in well characterised compounds.

No. 12, September 17, 1888.

The Compressibility of Gaseous Oxygen, Hydrogen, Nitrogen, and Air, up to 3000 Atmospheres.—E. H. Amagat.—At very high pressures oxygen, nitrogen, and atmospheric air have almost the same compressibility, which is of the same order of magnitude as that of liquids. At 3000 atmospheres it is approximately equal to that of alcohol under the normal pressure. The compressibility of hydrogen is much greater, nearly double. At 3000 atmospheres it is about equal to that of ether at the normal pressure.

On the Gallium Chlorides, and on the Value of the Elements of the Aluminium Group.—MM. Nilson and Otto Petterson.—The vapour density of gallium trichloride is 8·84 at 360°, 6·11 at 440°, 6·14 at 606°, 5·18 between 1000° and 1100°. The density calculated on the formula $GaCl_3$=6·081; hence gallium trichloride reaches its normal gaseous state below 440° and begins to dissociate above 606°. The gallium dichloride, $GaCl_2$, has the vapour densities 4·82 between 1000° and 1100°, and 3·56 between 1300° and 1400°. Aluminium and gallium displace 3 atoms, indium 2 atoms, and thallium 1 atom of hydrogen in dry hydrochloric acid. With the increase of the atomic weight there is an evident tendency of the elements of this group to form several combinations with chlorine. Aluminium has a single chloride, gallium at least two, indium three, and thallium four.

On Ferrous Chloride and the Chromium Chlorides.—MM. Nilson and Otto Petterson.—Ferrous chloride appears to have a more complicated constitution at lower temperatures, and is resolved at a white heat into molecules of the normal composition $FeCl_2$. The vapour density is 4·34 between 1300° and 1400°, and 4·29 between 1400° and 1500°. The density calculated for the formula $FeCl_2$=4·375. Two chromium chlorides are known to which the formulæ Cr_2Cl_6 and $CrCl_2$ are generally ascribed. The former has the vapour density 6·13 at 1065°, 5·51 at 1191°, 5·42 at 1277°, 4·82 at 1347°, 5·67 between 1100° and 1200°, 5·17 between 1250° and 1350°, and 4·58 between 1350° and 1450°. For the formula $CrCl_3$ the calculated vapour density is 5·47; above 1300° the density decreases. The authors have prepared Cr_2Cl_4 or $CrCl_2$ by heating chromic chloride in a current of pure dry hydrogen at a heat below that at which the glass of the tube becomes incandescent. Its vapour density is 7·80 between 1300° and 1400°, 7·27 between 1400° and 1500°, and 6·22 between 1500° and 1600°. The calculated density according to the formula $CrCl_2$=4·256.

No. 13, September 24, 1888.

This issue contains no chemical matter.

Bulletin de la Société Chimique de Paris. Vol. xlix., No. 11.

Determination of Total Nitrogen in Organic Substances.—MM. Cazeneuve and Hugounenq.—The authors place at the end of the combustion-tube for the length of 15 c.m. dry manganese carbonate. After having charged the rest of the tube as usual expel the air in the following manner:—Connect the combustion-tube with an air-pump by the intervention of an abductor tube 12 c.m. in length, suitably bent and connected with the combustion-tube by means of a caoutchouc stopper. An ordinary T manometer tube is introduced in the connection of the tube and the pump. Exhaust three times in succession, liberating each time carbonic acid from the manganese carbonate until the mercurial column has completely descended. Without ceasing to liberate carbonic acid connect the combustion-tube with the Dupré apparatus; collect pure carbonic acid, and then proceed with the combustion as usual.

Determination of Total Nitrogen in Urine.—MM. Cazeneuve and L. Hugounenq.—The authors recommend the method of Dumas with their modification, as above described, in preference to the Will-Varrentrapp and the Kjeldahl processes.

New Method of Determining Carbonic Acid in Solution.—Leo Vignon.—This paper will be inserted in full.

Thermo-chemistry of the Diazo-compounds.—Leo Vignon.

The Formation-heat of the Acetyl-acetonates and of Some Homologues.—Alphonse Combes.—These two papers do not admit of useful abstraction.

The Properties of Sodium Disulpho-persulphate.—A. Villiers.—This salt forms orthorhombic crystals soluble in 1·3 part of water at 15°. If re-dissolved in water they crystallise at ordinary temperatures in the anhydrous state, but take up two mols. of constitutional water if the liquid is refrigerated. The anhydrous salt is permanent in the air. It melts at 125° and at 140° it gives off sulphurous acid. The residue consists of sodium sulphate and sulphur, but no alkaline sulphide.

Zeitschrift fur Analytische Chemie. Vol. xxvii., Part 3.

Collection of the Specific Gravities of Aqueous Solutions.—A very useful memoir, but not capable of abridgment.

The Chemical Character of the Peptones and their Separation from Normal Albumen.—R. Palm.—The term peptone must signify a solution of protein in acids, chiefly in sulphuric and acetic acids, and probably in other acids. Potassium xanthogenate may serve to distinguish peptones from normal albumen. With the former it gives a precipitate at once, but with the latter only on the addition of on acid.

Analysis of Pure Wines from Alsace-Loraine, of the Vintage 1886.—Dr. C. Amthor.—Of no general interest.

Improvement in Washing-Bottles.—J. Sobiecky and V. Hölbling.—This memoir cannor be reproduced without the accompanying cut.

Apparatus for and Methods of Gas-Analysis.—This paper cannot be usefully reproduced without a number of illustrations.

Distillation. Prevention of Bumping.—A. Reissmann.—The author recommends the use of spirals of thick platinum wire filled with pieces of pumice-stone.

Prevention of Frothing.—H. Künz.—The author adds a little solid paraffin.

Small Laboratory Apparatus.—Notice of improved filters, washing-bottles, &c.

New Reagent for Salts of Copper.—Aliamet.—A solution of neutral sodium sulphite in which a little pyrogallic acid is dissolved, and which gives an intense blood-red solution in aqueous copper solutions of medium concentration.

Separation and Determination of Phosphoric Acid and Tungstic Acid.—Fr. Kehrmann.—1½ to 2 grms. of the compound (free acid or alkaline salts) are mixed with double the volume of the calculated quantity of caustic soda and a sufficiency of water, and boiled for half an hour in a covered porcelain or silver capsule. The clear solution, when cold, is mixed with twice the quantity of ammonium chloride which will furnish chlorine to combine with the alkali present, placed in a beaker, and, after adding one-fourth of the volume of ammonia, precipitated with magnesia-mixture. After standing for twelve hours it is filtered and washed with dilute ammonia to which a little ammonium nitrate has been added. To remove any traces of alumina and traces of ferric oxide the ammonium-magnesium phosphate is again converted into Sonnenschein's precipitate. The ammoniacal filtrate containing the tungstic acid is evaporated down upon the water-bath in order to expel free ammonia, and separated from the tungstic acid by desiccation with hydrochloric acid repeated at least four times. The tungstic acid is then perfectly washed by decantation with water acidified with a little nitric acid and mixed with a little ammonium nitrate, ignited at a dull red heat until the weight becomes constant, and weighed.

Detection of Sulphites in Presence of Hyposulphites and Sulphates.—A. Villiers.—From the *Bulletin de la Société Chimique.*

Detection of Nitrogen Compounds in Seleniferous Sulphuric Acid.—G. Lunge.—In case of a seleniferous sulphuric acid free from nitric acid the author observed the following reactions:—On adding a solution of diphenylamine in strong sulphuric acid there appeared at first no colouration. If a little water is stratified upon the acid mixture there appeared exactly the same "corn-flower blue" colour as in case of a sulphuric acid containing nitrogen acids. If seleniferous sulphuric acid is superstratified with solution of ferrous sulphate there appears firstly the same phenomenon as in presence of nitrogen acids, *i.e.*, a brownish yellow or yellowish red ring at the point of contact. This does not, however, disappear on warming, but becomes thereby, or on prolonged standing, darker, and the liquid is filled with red reduced selenium.

A General Reaction of the Polyatomic Alcohols.—D. Klein.—From the *Comptes Rendus.*

Detection of Saccharine.—Herzfeld and Reischauer.—The authors, after acidulation with phosphoric acid, extract the saccharine from sugar with ether and evaporate with ether.

Detection and Determination of Acetic Acid in Presence of Formic Acid.—D. S. Macnair.—From the Chemical News.

Determination of Nitrogen in Organic Matter.—B. B. Ross and L. W. Wilkinson.—From the Chemical News.

Determination of Oxalic Acid.—MM. Berthelot and André.—From the *Comptes Rendus.*

Behaviour of Toluidines with Phosphoric Acid.—L. Lewy.—For the quantitative determination of ortho- and paratoluidin in a mixture, they may be weighed as phosphates and the phosphoric acid determined.

Separation of Paratoluidin Ortho- and Metasulphuric Acid.—E. A. Schneider.—From the *American Chemical Journal* and the Chemical News.

Determination of Ammonia in Urine.—C. Wurster.—The author abbreviates the process of Schlösing by expelling the ammonia at 50° at a reduced pressure.

Determination of Mercury in Urine.—C. Brasse.—The author steeps a piece of fine brass wire gauze for twenty-four hours at 80° in 100 c.c. of acidulated urine, expels the mercury adhering to the brass by heating in a porcelain crucible, and lets the mercury deposit upon a refrigerated gold cover.

Detection of Alcohol, Acetone, and Aldehyd in Animal Liquids.—P. Albertoni.—The author uses the iodoform test, the reactions of Vitali and of Legal and the examination of the reductive power with solution of silver.

The Precipitation of Albumenoids by Salts.—S. Lewith.—Of the salts examined the most active are:—Potassium chloride and acetate, sodium chloride, sulphate, nitrate, chlorate, ordinary phosphate, and acetate, calcium chloride and nitrate, and magnesium sulphate. The author has not extended his enquiries to the salts of aluminium.

Detection of Egg-Albumen, Propeptone, and Peptone.—C. Possner.—The author uses a modification of the biuret test.

On Mucoid Substances.—O. Hammarsten.—An examination of the mucine of the salivary gland of the lower jaw.

Moniteur Scientifique, Quesneville.
Series 4, Vol. ii., August, 1888.

On Saccharine.—Dujardin Beaumetz.—In these two memoirs the author, whilst admitting the medicinal value of saccharine in certain cases, protests against its use in articles of food. It retards the action of the gastric juice upon albumenoid substances, as well as the saccharification of starch by ptyaline. The experiments of Dr. Worms prove that in some persons the prolonged ingestion of saccharine in small doses is followed by pains in the stomach and disturbed digestion. These symptoms ceased when the saccharine was discontinued and reappeared on its resumption. Saccharine has already found its way into the hands of sophisticators. The Academy of Medicine has formally concluded that saccharine must not be regarded as a food, but merely as a medicine.

On the Greater or Less Facility with which Glass may be Worked with the Gas-blowpipe.—Dr. Otto Schott.—Certain kinds of glass, if worked before the lamp, become dull and wrinkled on the surface, and cannot be brought to the desired form. On the contrary, the glass made in the Forest of Thüringen can be softened and hardened again, can be blown and melted repeatedly without any alteration in its appearance and in its texture. The glass-manufacturers of the district maintain that this property is due to the use of a peculiar sand, found at Martinsroda, and that all other kinds of quartz sand, especially the pure sands of Brandenburg, are unfit for use. The Martinsroda sand is found to contain 3·66 per cent of alumina. The glass made with this sand contained 3 per cent of alumina. Synthetic experiments confirmed the conclusion that the especially workable quality of the Thüringen glass is due to alumina.

Indirect Determination of Alcohol in Beer.—D. Sidersky.—The author gives a method of determining the alcohol in beer, based upon the difference of density before and after the expulsion of the alcohol. On expelling the alcohol from beer by boiling until it is reduced to half its volume, and then making it up to its original volume with distilled water, we have a liquid of greater density than the sample of beer. If we call d the density of the beer not boiled and D that of the beer freed from alcohol, the difference, $D-d$, will express the increase of the specific gravity of the beer in consequence of the replacement of a certain volume of alcohol by distilled water. If we execute the same operation with a mixture of water and alcohol containing the same proportion of alcohol as the sample in question, we shall evidently have the same increase of density due to the replacement of the same quantity of alcohol by water. If we take distilled

water at 15° as the unit of density and calculate the proportion of alcohol per cent, we have the equation—

$$D - d = 1 - X,$$

in which X expresses the density of a mixture of water and alcohol of the same proportion as the beer in question. Hence we deduce $X = 1 + d - D$, and find in Gay-Lussac's alcoholometric tables the degrees corresponding to the density X, represented by the value $1 + d - D$, D and d having been determined by direct experiment.

Purification of Crude Alkali and Simultaneous Production of Ammonia.—T. T. Mathieson and Jos. Hawliczek.—The compounds of cyanogen formed in the fusion of soda or potassa on the Leblanc process are commonly eliminated either by heat or by oxidation with an alkaline nitrate. In either case the nitrogen is lost. The authors, instead, treat the product of the fusion with steam at 300° to 500°. The nitrogen is thus liberated as ammonia, and may be collected in the usual manner. The crude soda, as taken from the revolver, is rapidly broken up and placed in the apparatus where it is to be steamed. It is let cool down to 300° to 500°, as at higher temperatures the ammonia is destroyed, and superheated steam is introduced. When the ammonia ceases to escape the temperature is raised to 550° to 650°, and steam is again introduced, when the sulphur compounds are introduced in turn and the sulphuretted hydrogen evolved is collected and utilised in the regeneration of sulphur, or for any other purpose.

Vermillionette.—This pigment, sometimes erroneously believed to be a red ultramarine, is merely a red lake of eosine, and of course very perishable on exposure to light.

Patents issued at Berlin.—A list of German patents, relating chiefly to colouring-matters.

Determination of Carbon in Steel.—B. Blount.—From the CHEMICAL NEWS.

MISCELLANEOUS.

Metallurgical Department, King's College, Strand, London.—We are asked to state that there are three or four free admissions to the Laboratory and to the Lectures, obtainable through the City and Guilds Institute for the promotion of Technical Education. Enquiries may be addressed direct to Prof. Huntington at King's College. Work commences this week. The course of Lectures is designed for all those who in any way have to do practically with the applications of metals. It treats of the principles of the methods by which metals are obtained from their ores, and the means by which they are rendered suitable for the various requirements of the Arts. Especial attention will be devoted to the Metallurgical requirements for the Technological Examinations of the City and Guilds of London Institute in Metal Plate Work, Plumbing, and Iron and Steel, and for Whitworth Scholarships and Science and Art Department Exhibitions. The instruction given to each student in the Laboratory is regulated by his special requirements.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Cleansing Stone—Perhaps some of your scientific correspondents will kindly inform me through the CHEMICAL NEWS if there is any other method of cleansing stone which has been exposed to the smoky atmosphere of Manchester than the unscientific process of scouring with stone and grit, thereby damaging the sharp arrises and finely carved portions? A weak solution of fluoric acid is found to be effectual in removing this grimy deposit from glass, through the action of the acid on the glass itself, but is entirely powerless in its action on stone. Painting is objectionable because of its stucco appearance when done.—J. R.

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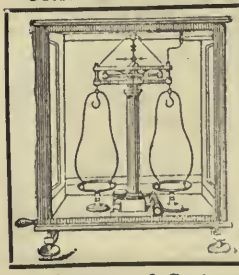

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1508.

ON THE ACTION OF INCANDESCENT PLATINUM WIRE ON GASES AND VAPOURS.

By Dr. W. R. HODGKINSON, F.R.S.E., and F. K. S. LOWNDES.

In a letter to *Nature* some weeks ago a short account of some experiments was given by one of us on the action of an incandescent platinum wire upon various gases and vapours. Since this publication we have considerably extended the experiments in several directions.

The apparatus used was in most cases extremely simple, consisting merely of a glass globe having two or three side openings. In the case of vapours, a vessel with two necks was used, through one of which a cork or glass tube conveying thick platinum wires was passed, the wires terminating inside the vessel in a coil of thinner material than the leads. The substance to be experimented upon was put at the bottom of the vessel and vaporised by a Bunsen burner. When a gas was under investigation three necks were required to the globe, one for the wires, as in the other case, the others as inlet and outlet respectively.

The globe having become filled with the gas or vapours, a powerful electric current was sent through the wire, sufficient to cause it to become white-hot, or just short of melting. It was maintained at this temperature for various lengths of time, and the effect on the gas and the platinum itself noted.

The first substance we experimented upon was chlorine. A stream of this was sent into the globe for some time in order to expel all the air. The wire was then rendered incandescent. Immediately, a white glow—not of very great magnitude—was seen to extend round the white-hot spiral of wire; that this was not due to irradiation or any optical effect was proved by its not retaining the same shape, and also by its extending more upwards than downwards, as a flame. The current was stopped after passing for about twenty to forty minutes in the various experiments.

The walls of the vessel were thus found thickly coated with a yellow deposit of platinous chloride, whilst on the platinum wire itself were formed very fine crystals of metallic platinum. Any substance, such as graphite, charcoal, or pieces of minerals, placed within the spiral during the experiments became coated with a brilliant deposit of the platinum crystals, which in these cases were very difficult to remove.

With vaporised bromine results differing considerably to the last were obtained. Platinous bromide was formed, but in much less quantity than platinous chloride in the case of chlorine, and no crystals whatever appeared. The flame, however, playing about the wire was much increased.

Iodine produced only a trace of platinous salt, no crystals, but a very large flame, which, indeed, upon making the flask very hot by external heat, filled the whole of the upper part of the vessel. In the spectroscope no bright lines were visible, a continuous spectrum crossed by the absorption lines of iodine being produced. The production of the crystals of platinum in the experiments with chlorine point to the conclusion that the platinous chloride must have been in a state of vapour without decomposition, otherwise it could not have come into contact with the hot wire after being formed. It seems probable that it was formed on parts of the wire comparatively cool, and vapourised as soon as formed. On coming in contact with the hottest portions of the spiral, which were probably far above its dissociation point, it is instantly decomposed, and the platinum deposited in the form of crystals. The formation of volatile chloride of platinum is quite unprecedented, and seems remarkable when we take into account both the instability of the platinum compounds under heat and the character of platinum itself.

To complete the series of halogens, we used for our next experiments fluoride of silicon, and in this series the greatest precautions were used to exclude moisture. The whole apparatus was allowed to stand for five hours over strong sulphuric acid. A stream of the gas was then caused to pass through for half an hour longer, having to flow, both on entering and leaving the globe, through strong sulphuric acid. There was not the slightest deposit of silica on either the globe or the tubes leading to it, proving that no moisture was present. After passing the current for some forty minutes, it was noticed that the top part of the globe was deeply corroded and the wire itself was covered with a mass of crystals of silicon, a large number of which had fallen and collected at the bottom of the globe. It seems quite certain that the corrosion of the vessel could only be due to liberated fluorine. If hydrofluoric acid had been present it would have indicated its presence by etching the glass before the wire was incandescent; and the formation of silicon crystals also points to the same conclusion.

(To be continued).

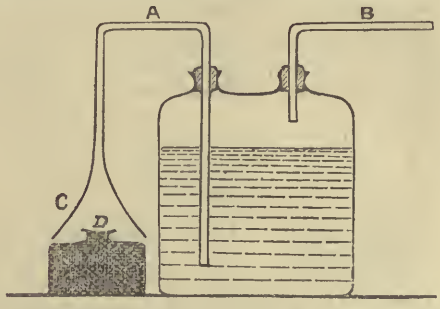
Royal Military Academy, Woolwich, October 8, 1888.

A NEW FORM OF SULPHUR DIOXIDE APPARATUS.

By the Rev. E. RATTENBURY HODGES.

I have just devised a simple arrangement for the preparation of sulphur dioxide solution.

A Woulff's bottle, having two necks, is provided with two bent glass tubes, A and B, fitted in with corks in the usual manner. The tube A reaches nearly to the bottom of the bottle, the other end being attached by a short piece of indiarubber tubing to an inverted glass funnel, C. Beneath this latter, and resting on a wood block or ring of a retort stand is a small iron dish, D, whose diameter allows about the eighth of an inch of air space.



To set the apparatus in action, the bottle is two-thirds filled with water and the tubes are replaced. Fragments of sulphur are now put in the dish, lighted, and placed under the funnel, and the tube, B, connected with a Geissler filter-pump, which is put in action. By this means the SO_2 evolved is readily drawn into the water and dissolved. This method takes less time, and there is also less risk of breakage of apparatus than by that usually followed, *i.e.*, by the decomposition of sulphuric acid, a process not altogether free from danger to the operator.

Nottingham, October 10, 1888.

LIST OF ELEMENTARY SUBSTANCES ANNOUNCED FROM 1877 TO 1887.

Compiled by H. CARRINGTON BOLTON.

Date.	Name.	Source.	Authority.	Reference.*
1877.	Neptunium	Columbite.	Hermann.	J. prakt. Chem., 2, xv., 105. Chem. News, xxxv., 197.
	Lavoesium	Pyrite.	Prat.	Le Monde pharmaceutique.
	Mosandrum	Samarskite.	J. L. Smith.	Compt. rend., lxxxvii., 148. Chem. News, xxxviii., 100.
	Davyum	Platinum ores.	Sergius Kern.	Chem. News, xxxvi., 4, 114, 155, 164; xxxvii., 65.
1878.	"New earths" ..	Unnamed mineral.	Gerland.	Chem. News, xxxviii., 136.
	"X"	Gadolinite.	Soret.	Compt. rend., lxxxviii., 1062.
	Philippium	Samarskite.	Delafontaine.	Compt. rend., lxxxvii., 559. Chem. News, xxxviii., 202.
	Decipium	Samarskite.	,,	Compt. rend., lxxxvii., 632. Chem. News, xxxviii., 223.
	Ytterbium	Gadolinite.	Marignac.	Compt. rend., lxxxvii., 578. Chem. News, xxxviii., 213.
1879.	Scandium	Gadolinite.	Nilson.	Compt. rend., lxxxviii., 645. Chem. News, xl., 76.
	Norwegium	Gersdorffite.	Dahll.	Compt. rend., lxxxix., 47. Chem. News, xl., 25.
	Uralium	Platinum.	Guyard.	Monit. scientif., (3), ix., 795. Chem. News, xl., 57.
	Samarium	Samarskite.	Lecoq de Boisbaudran.	Compt. rend., lxxxviii., 322. Chem. News, xl., 99.
	Barcenium	(Misapprehension).	Wagner's Jahresbericht.	Jsb. chem. Tech., 1879, 8.
	Thulium	Gadolinite.	Cleve.	Compt. rend., lxxxix., 478.
	Holmium	Gadolinite.	,,	
	Columbium	Samarskite.	J. L. Smith.	Nature, xxi., 146.
	Rogerium	Samarskite.	,,	
	Vesbium	Lava.	Scacchi.	Ber. d. chem. Ges., xxi., 353. Chem. News, xli., 116.
1880.	Comesium		Kaemmerer.	Chem. Ztg., 1880, 273.
	Yα and Yβ	Gadolinite.	Marignac.	Compt. rend., No. 16, April, 1880.
1881.	Actinium	Zinc ores.	Phipson.	Chem. News, xliv., 73, 138, 191.
1882.	Didymium β ..	Gadolinite.	Cleve.	Chem. News, xlv., 273.
1883.	Nameless	Platinum ore.	Th. Wilm.	Ber. d. chem. Ges., xvi., 1298.
1884.	Idunium	Vanadium ore.	Websky.	Sitzungsb. Ak. Wiss. Berlin, xxx., 661.
1885.	Neodymium ..	Didymium.	Von Welsbach.	Chem. News, lii., 49.
	Praseodymium ..	,,	,,	
	Zα	,,	Lecoq de Boisbaudran.	Compt. rend., cii., 153. Chem. News, liii., 63.
	Zβ	,,	,,	
	Unnamed	Cerite.	Brauner.	J. Chem. Soc., xlvii., 879.
1886.	Zγ	Terbia, &c.	Lecoq de Boisbaudran.	Comp. rend., cii., 153. Chem. News, liii., 63.
	Germanium	Argyrodite.	Winkler.	Ber. d. chem. Ges., xix., 210. Chem. News, liv., 136.
	Dysprosium	Holmium.	Lecoq de Boisbaudran.	Compt. rend., cii., 1005.
	Austrium	Orthite.	Linnemann.	Nature, xxxiv., 59.
	Dα	Didymium.	Crookes.	Chem. News., liv., 13.
	Sβ	Samarskite.	,,	
	Gα	Gadolinite.	,,	
	Gγ	,,	,,	
	Gδ	,,	,,	
	Gε	,,	,,	
1886.	Sδ	Samarskite.	,,	
	Gζ	Gadolinite.	,,	
	Gη	,,	,,	
	Polymnestum ..	Glacial debris, Scotland.	Pringle.	Chem. News, liv., 167.
	Nameless (1) ..	,, ,,	,,	
	Erebodium	,, ,,	,,	
	Nameless (2) ..	,, ,,	,,	
	Gadenium	,, ,,	,,	
	Hesperisium ..	,, ,,	,,	
	Gadolinium = Yα..		Marignac.	Compt. rend., civ.
1887.	Erα	Erbia.	Krüss and Nilson.	Ber. d. chem. Ges., xx., 2134.
	Erβ	,,	,,	
	Tmα	Thulium.	,,	
	Tmβ	,,	,,	
	Smα	Samarium.	,,	
	Smβ	,,	,,	
	Xα to Xη (7) ..	Soret's X.	,,	
	Diα to Diϑ (10) ..	Didymia.	,,	

* The abbreviations of Journal titles are the standard prepared by the Committee on Indexing Chemical Literature, American Association for the Advancement of Science. (See Chem. News, vol. lvi., p. 273).

ANALYSIS OF THE ANCIENT MORTAR FROM THE ROMAN WALL OF LONDON.*

By JOHN SPILLER, F.C.S.

Early in June last I was permitted to inspect and take samples of the fine piece of old London wall recently discovered when digging the foundations of the new Post Office buildings in St. Martin's-le-Grand. It is in every way a splendid relic of Roman work, measuring roughly, so far as the excavations have extended, nearly 120 feet long by about 13 feet in total height, the thickness not having yet been ascertained. Built of squared blocks of Kentish Rag, interstratified pretty regularly at every fifth course by a double or, near the bottom, triple layer of red tiles, and bound together by a white mortar, which for strength and endurance far surpasses that commonly used in the present day.† The scientific interest attaching to its composition induced me to undertake its chemical analysis, whereby I might compare it with other ancient Roman mortars, particularly with that from the castrum of Burgh, which was reported to the Norwich Meeting of the British Association, 1868, as well as with other mortars of more recent date.

The plan of examination was to crush the mortar, pick out any large stones weighing more than a grm. (these being constituents of "concrete" rather than of mortar), and to act upon 50 grms. at least of the fair average sample with a good excess of very dilute hydrochloric acid (1 part concentrated acid to ten parts of water), giving sufficient time for all the lime to be dissolved in the cold, washing the sandy residue once more with diluted hydrochloric acid, and finally with water.

It is customary to say that the hydrochloric solution will contain all the so-called "soluble silica," but I found in this particular mortar that nearly 11 per cent more could be readily dissolved by digesting the sandy residue in a cold weak solution of pure caustic soda. This was to me an unexpected result, may indicate the presence of a decomposable silicate, and which ought to be taken account of in future analyses. It will necessitate a re-examination by this plan of the Burgh mortar when I have found an opportunity to collect further samples.

I may here state that two samples of ordinary builders' sand were digested with acid, washed with water, and then tested with soda, but neither of them gave any appreciable amount of soluble silica; whereas a twenty-years old mortar contained 0·65 per cent, and another mortar taken from a brick wall at Canonbury, said to be 100 years old, gave 1·1 per cent of (alkali) soluble silica. The London wall, giving ten times this amount, raises a question of some importance: Was pozzuolana brought from Vesuvius to London by the Romans, and employed with ordinary sand and lime in the manufacture of this mortar; or is the large amount of soluble silica or silicate now found therein the direct result of long contact, through many centuries, of plain sand and lime? Which of these possible explanations is the true one I am unable to say at the present moment. It will require extended research to settle the point, and a whole series of analyses will have to be made, not only of ancient Roman mortars, but of Norman and mediæval products, besides others of later date. The subject is one of paramount interest to architects and builders, and as I cannot find any record of "soluble silica" having been sought for in this particular manner, I venture to press upon the attention of my fellow chemists the importance of looking at the matter from my point of view.

To return to the analytical results: Carbonic acid was accurately determined by dissolving 50 grms. of the Roman mortar in dilute hydrochloric acid, and passing all the evolved gas through a train of potash bulbs and dry potash tube. The hydrochloric solution, made up to the bulk of one litre, was parcelled out for the estimation of the several constituents contained therein, 250 c.c. being in most cases employed. The insoluble residue (sand and brick particles) was treated in the manner already described, when, as I have said, nearly 11 per cent (or, more exactly, 10·44 per cent, calculated on the weight of the mortar originally taken) was readily dissolved in the caustic alkali, whilst 0·52 only of so-called soluble silica was found in the hydrochloric solution.

100 parts of the Roman mortar (air-dried) gave:—

Sand and brick	46·48
Acid-soluble silica	0·52
Alkali-soluble silica	10·44
Alumina	3·00
Iron peroxide	0·48
Lime	20·02
Magnesia	0·76
Carbon dioxide	13·03
Sulphuric anhydride	0·37
Sodium chloride	trace
Water and loss	4·90
	100·00

Probable Arrangement of the Constituents.

Sand	45·95
Brick particles	0·53
Alumina	3·00
Peroxide of iron	0·48
Carbonate of lime	27·73
Silicate of lime	15·19
Sulphate of lime	0·63
Carbonate of magnesia	1·59
Water and loss	4·90
	100·00

The mortar was originally made up of about 3 parts by weight of sand to one part of dry lime. In modern practice it is usual to employ more sand and less lime.

PS.—It having been suggested in the course of discussion, by Mr. Walter F. Reid, that an admixture of powdered flints might account for the high percentage of soluble silica found in the mortar, this ingredient being supposed to be soluble in cold caustic alkali, I have since put this to the test of experiment, using a perfectly fresh flint from the chalk near Caterham, reducing it to a fine powder, and digesting with a five per cent solution of pure caustic soda. No more than a mere trace of silica was dissolved by 24 hours' contact in the cold. Another sample of flint behaved in exactly the same way, so that the suggested explanation does not hold good. On the other hand, a sample of mortar from the square Roman bath at Bath contained fully as much soluble silica as the London wall.

* Read before the British Association, Bath Meeting, Section B.

† For further particulars of structure and measurement (with pictorial sketches) see the *Builder* of May 5 and the *Graphic* of May 19 last.

ARSENIC IN THE HOME.

By A. W. STOKES, F.C.S., F.I.C.

Some few months ago I examined for a large firm of household furnishers, as well as for numerous private individuals, a number of samples of the then fashionable "Imitation Indian Muslins" and cretonnes. More than 100 samples were examined, and 23 per cent of these were found to contain arsenic in appreciable quantities. In all qualitative cases Marsh's test was used, and only such samples as gave within five minutes indications of arsenic were marked arsenical.

Several were quantitatively examined. The highest proportion of white arsenic found was $2\frac{1}{10}$ grains per square yard.

The colours in which arsenic was principally present were the terra-cotta reds and the greenish browns.

There being some doubt whether these materials would give off arsenical vapours, I made the following experiments:—

Some pieces of the arsenical muslins and cretonnes, measuring altogether 300 square inches, were placed in a glass tube 3½ feet long and ¾ inch diameter, and air was forced through the tube for six hours. The air passed among the folds of the material, then through a smaller tube, kept red hot, and finally bubbled through some nitrate of silver solution. At the end of the six hours there was not the least indication of any arsenic having been evolved. The tube was then kept at a temperature of about 100° F. (blood-heat) for six hours longer while air was passing through the tube; again no arsenic was given off.

From this it would seem that under ordinary circumstances arsenic would not be evolved by such fabrics. Yet in two cases samples of these materials were brought to me by medical men, in which well-marked symptoms of arsenical poisoning were ascribed to their use. In one case some six or eight work-girls employed in making up some of this material were all taken ill with the same symptoms of arsenical poisoning. Of course, in such case the material, when pressed with hot irons, is heated far beyond blood-heat, and minute particles are detached and float in the air of the work-room. That the arsenic is held very loosely by the fabric was evidenced by dipping some of the fabric in water; plenty of the arsenic was at once taken up by the water. It would seem at first as if this might be due to arsenic having been used as a preservative for the size or starch present as "stiffening"; but then these muslins have no stiffening.

Wishing to see whether other materials were subject to arsenical colouring, I examined thirty other articles in use at home, including plushes, velvets, carpets, mats, linings, silks, druggets, and fringes.

In only one sample, a little flax mat of green colour, was there any arsenic to be found. This mat, which weighed 9 oz., contained 21 grains of white arsenic.

I found my infant playing, lately, with a small glazed cardboard box of a green colour that had once contained chocolate, and that had been obtained from one of the automatic supply boxes. After the manner of infants, he was occasionally sucking this. Out of curiosity I tested it, and found that the "surface-paper," measuring 5 inches by 1¾, contained $\frac{1}{10}$ of a grain of white arsenic.

In all these cases the quantity of arsenic found is small, and it may be, under ordinary circumstances, quite harmless; but in all cases its presence is quite unnecessary. Other colouring-materials could equally well be used in which there is no possibly noxious ingredient.

Of wall-papers submitted to me, 10 per cent are found to contain arsenic. This is a high proportion, but then only suspected samples are sent for analysis. One of my rooms I found thus papered.*

Omitting articles in which its occurrence has been purely accidental, arsenic has been found of late years to be present in some samples of muslins, cretonnes, wall-papers, playing-cards, the glaze of some enamelled stew-pans, the paper of fancy boxes, and in some furs. These last are usually the furs prepared by amateurs.

So that we may picture an infant placed by an unfortunate concurrence of circumstances in a room covered with arsenical paper, having its cot draped with muslin or cretonne, fed on food prepared in a glazed saucepan, itself covered by a rug, and playing with some fancy box of sweets or toys, all of these containing a minute but unnecessary amount of arsenic.

One has no wish to be an alarmist, or in any way to harass trade, and it must freely be acknowledged that cases of any ill results whatever being traced to the use of these articles are very rare. None the less, seeing how unnecessary they are, and how each year arsenic seems to be finding its way into new quarters, it seems advisable to stop its further progress. This can only be done by prohibiting by law, as in some other countries, the use of arsenic for producing colours. Neither the ultimate seller nor the purchaser can really protect himself, the trouble and the expense would be too great; but by making the manufacturer answerable the evil might easily be remedied.

* Neither are those who avoid wall-paper altogether safe. A lady some two or three years ago had her rooms painted, and covenanted with a Sanitary Decorating Company that they should use on the walls paint containing neither lead nor arsenic. Pieces of the moulding she brought to me contained both lead and arsenic in the colour.

DETERMINATION OF BROMINE IN SEA-WATER BY FRACTIONAL TITRATION.

By F. GUTZKOW.

This method of quantitative determination of bromine consists of three operations—

1. Separation of the bromine as cuprous bromide.
2. Conversion of the cuprous bromide into zinc bromide.
3. Titration by hypochlorite of sodium.

1st Operation.—*Separation of the Bromine as Cuprous Bromide.*—I mix 250 c.c. of filtered sea-water from the Pacific Ocean, to which a drop or two of sulphuric acid has been added, with 100 c.c. of a solution containing 25 grms., more or less, of crystallised cupric sulphate. To this clear solution, in which the copper may be assumed to exist as cupric chloride, I add from a graduated glass a solution of ordinary good sodium sulphite, the strength of which I need not know, until the brown flocculent precipitate which each addition produces will dissolve more and more slowly. It is easy to find a point when the brown precipitate has dissolved by digesting, but the solution remains slightly turbid from shining crystals of cuprous bromide. The separation of crystals increases rapidly, cuprous chloride being also separated. An excess of sulphite of soda does not matter much. By heating to about 40° C. the green liquid becomes blue again. Then, after cooling by water, another addition of sodium sulphite is made, say one-third of the volume previously used, again heated until the blue colour distinctly reappears (about 70° C.); the flask is once more cooled by water and allowed to settle, after removing any traces of sodium sulphite remaining in the neck by shaking with the liquid. It is advisable to loosely cork the flask. It will be found that the precipitate of mixed cuprous chloride and bromide is an unusually heavy one, settling rapidly from a perfectly clear liquid, from which any little particles floating on the surface can be made easily to sink (by a glass rod or judicious shaking), so that the liquid may be decanted to almost the last drop after short settling. The solution has become strongly acid by the sulphuric and sulphurous acid formed through the reaction between cupric chloride and sodium sulphite. For the 250 c.c. of sea-water employed about 3 grms. of copper have been separated, varying in amount somewhat according to the temperature after heating and after cooling. Heating to the boiling point only increases unnecessarily the copper separated. The second addition of sodium sulphite I found necessary for removing the last trace of bromine. Now, in order to test if all bromine has been separated, I add to the decanted liquid another portion of sodium sulphite, say as much as the second time, heat and cool as before, treat the precipitate by zinc and hydrochloric acid, as will be described hereafter, filter some of the solution of zinc chloride obtained into a test-tube and test by one drop of the standard chlorine solution and chloroform whether, after shaking, the chloroform turns yellow. If it does not it is certain there is no trace left in the decanted liquid.

By these operations bromine can be very conveniently and completely separated in about ten minutes. Enough cupric sulphate ought to be added to form cupric chloride also from the sodium sulphite, as this is partially converted

into sodium chloride by the formation of cuprous salts. In analysing saline solutions other than sea-water, I ascertain the specific gravity and the corresponding percentage in sodium chloride from the tables, and reckon three parts of crystallised cupric sulphate for one part of sodium chloride, assuming all dissolved salts to be sodium chloride, as an excess of copper does not matter.

2nd Operation.—*Conversion of Cuprous Bromide into Zinc Bromide.*—This is accomplished by zinc with the addition of a little hydrochloric acid. The operation is an easy one, and would seem to require no explanation. But for the 3rd operation, the titration, I require a small volume, say 25 c.c., in our case. A judicious economy of water and acid is, therefore, imperative. The precipitate in the flask is digested with about 100 c.c. of cold water, to which about 1 grm. of sulphuric acid has been added. The settled liquid is decanted as before, the last portion over a very small filter. Any iron which the cupric sulphate may have contained is now reduced to a no longer appreciable amount, and the sulphurous gas much reduced. But in order to destroy the last trace of the latter, I add a few drops of sodium carbonate and spread the crystalline powder around the flask. After one or two minutes enough oxychloride will be formed to answer the purpose afterwards. Now I rinse the contents of the flask into a porcelain dish, using only a few cubic centimetres at one time; heat in a test-tube about 5 c.c. water, with ½ c.c. hydrochloric acid, and filter over the small filter I had been using into the flask. A little more water applied to both filter and flask will clean both sufficiently. The dish is heated on a water-bath, and when by smell I detect no sulphurous gas, I add one large amply sufficient piece of zinc.

The white crystals will soon be replaced by copper and a clear solution of cuprous chloride in hydrochloric acid. The finished reduction I recognise by touching with the point of a glass rod first the liquid and then a drop of sulphuretted hydrogen water spread on a porcelain plate. Enough acid must be present to prevent the formation of oxychloride of zinc. The contents of the dish, copper and all, are filtered over a small filter, directly into a small graduated cylinder, and ought not to give more than 10 or 15 c.c. filtrate. The copper is then fully sweetened into another porcelain dish with about 25 c.c. of hot acidulated water, and the filtrate evaporated to about 5 or 6 c.c. with the addition of one or two drops of sodium carbonate, then made acid again and added to the 10 or 15 in the graduated cylinder, and the water used for rinsing the dish utilised to fill up to 25 c.c.

3rd Operation.—*Titration by Hypochlorite of Sodium.*—I must suppose that the chemist who takes interest in the subject treated here is acquainted or makes himself acquainted with what Fresenius in the sixth edition of his celebrated book remarks on titration of bromine. He will find that all these titrations are based on liberating bromine by chlorine and on the colour imparted by free bromine to water, or chloroform or other absorbent. My method offers nothing new in that respect. Generally chlorine water is used as standard solution, which is the most changeable liquid employed in volumetric analysis. Figuier removes the bromine liberated by boiling; Reimann by chloroform. In the first case it requires better eyes than mine to recognise colouring when there there are only one or two milligrms. of bromine left, and in the second, frequent removal of the chloroform is necessary; for, while the decolouration of a small drop of chloroform slightly coloured is a sure and delicate test, the change of colour in a highly coloured drop of chloroform is a very coarse one.

As standard solution I use hypochlorite of sodium or potassium, that is ordinary "Eau de Javelle," as prepared by druggists (by treating "chloride of lime" with sodium or potassium carbonate), containing, generally, from one to two per cent of chlorine, which may be set free by an acid. The slight excess of the carbonate employed does not interfere. I dilute one part of the commercial liquid with five parts of water, and test its strength by a normal solution of potassium bromide, acidulated by sulphuric acid. This normal solution I prepare by dissolving 1 grm. potassium bromide in water, add diluted sulphuric acid containing about 2 grms. SO_3 and fill up with water to say one-half litre. Then I ascertain the bromine in a given volume either by argentic nitrate and chlorine gas or by titration with the standard solution of hypochlorite of sodium, which has been previously assayed for chlorine by one of the usual methods. Deducting the volume used for assay I dilute until the normal solution contains one milligrm. per cubic centimetre.

Although the standard solution of hypochlorite of sodium is by no means unalterable, still it is much less changeable than chlorine water. For instance, a solution prepared three weeks ago and indicating 100 m.grms. of bromine by 18·8 c.c., requires to-day 19·6 c.c., weakening by 4 per cent. This weakening is, however, no matter, as it amounts to only 0·01 c.c. per day for 25 m.grms. of bromine, and I recommend, in all cases, to test its strength immediately previous to the assay on the unalterable normal solution of bromine. This is preferable to its test by an iodide of potassium, &c., solution, which Fresenius ("Quant. Anal.," § 143, β), recommends, deviating in this one little instance from the fundamental principle of volumetric analysis expressed by him elsewhere, that the test ought to be made, if possible, always in the same manner as the assay.

The novelty of my method is a kind of fractional titration which allows to foretell the final reaction on an aliquot portion of the liquid, and—in the case of bromine—to compare the colour before and after addition of the chlorinated standard solution. This kind of titration is advantageous also for other determinations, especially those which have a very sudden final reaction, as, for instance, the analysis of caustic soda. For the last named kind of analysis I proceed as follows:—The apparatus consists of a flask provided with a well-fitting cork with two holes. Through one of these holes passes a little bent glass tube, stopping short at the cork inside and connecting outside with a rubber tube and clamp or "clip." Through the other hole passes a long funnel to nearly the bottom of the flask. I prefer the kind of funnel called thistle-shape, or better, poppy-head shape. It must hold 30 to 40 c.c. A mark by file or paper glued on shows when the funnel is filled with 20 c.c. I measure the solution of caustic soda to be tested and dilute to a round figure, say 100 c.c., add litmus and fill into the flask, opening the clamp. By blowing through the tube I raise 20 c.c. into the funnel and close the clamp. I note the stand of the burette, say = 0·00 c.c., add one drop of standard acid; the solution remaining blue, I may add four more drops for the 80 c.c. in the flask, because ⅕ = 20 c.c. were not changed. I do so; find that I have been using 0·25 c.c. in five drops, that the liquid remained blue, and that I may add safely 4 × 0·25 or 1·25 c.c., including the five drops already given. I bring the burette to 1 c.c. to get at round numbers; still blue colour. I may add four more c.c., and do so, ½ c.c. at a time, stirring with a little glass rod which I leave always in the funnel, and observe that with 3 c.c. the contents remained blue, but become red with 3½ c.c. Now I know that the final reaction will occur between 3 × 5 = 15, and 3½ × 5 = 17½ c.c. I open the clamp and run standard acid to the 15 c.c. mark of the burette, shake and wash the funnel by raising and lowering repeatedly the the mixed liquid. I raise again to 20 c.c. in the funnel, close the clamp and begin my second test, adding, as before, 1 drop; the liquid remaining blue, I add 4 more. Still blue. I may, consequently, give 5 × 0·25 c.c. = 1·25 c.c. I do so, but only 0·10 c.c. or two drops at a time, because I know that I am approaching the final reaction below 17·5 c.c. Having added 0·30 c.c., the liquid remains blue, but turns red at 0·40 c.c. I may add 5 × 0·30 but not 5 × 0·40 c.c. I open the clamp and proceed as before, bringing the burette to 16·50 c.c. I raise again 20 c.c.

which I still, to be on the safe side, count as ½, although it has became now nearly ⅙ of the whole. I add one drop of acid: blue, another: red. I go no further, because I know I am within 3 drops of the final reaction. I remove cork and funnel and add the next drop directly to the flask, find that the third drop will turn red, and read 16·9 c.c. off the burette.

The following table will show how the observations may be conveniently noted, + and − signifying respectively blue and red:—

Addition.

	To $\frac{1}{5}$ Made. C.c.		To the Whole. Allowed. C.c.	Forbidden. C.c.	Made. C.c.	Stand of Burette. 0·000 c.c.
No. 1.	1 drop	+	5 dr. = 0·25	—	—	—
	0·25	+	1·25	—	—	—
	0·50	+	—	—	—	—
	1·00	+	5·00	—	—	—
	3·00	+	15·00	—	15·00	15·00
	3·50	−	—	17·5	—	—
No. 2.	1 drop	+	0·25	—	—	—
	0·10	+	—	—	—	—
	0·20	+	1·00	—	—	—
	0·30	+	1·50	—	1·50	16·50
	0·40	−	—	2·00	—	—
No. 3.	1 drop	+	0·25	—	0·25	16·75
		+			3 drops	16·90

For the analysis of bromine I modify my apparatus as follows:—The flask holds about 70 c.c. and has a round bottom, if possible, egg-shape, and short and wide neck, so that a cork with three borings may be fitted. One of these holes serves for a small bent glass tube, with rubber tube and clamp attachment as described above. Instead of one funnel I have two, as much as possible of equal size and of similar shape as described, each holding 10 or 15 c.c. Into one of the two cups I place a short and thin glass-rod, bent so that the heaviest part is inside the cup, and graduate (with the little glass-stirrer inside) for one and for five c.c. The tube of the other funnel is bent above the cork, so that both funnels will rest side by side in equal and least possible height above the cork. Both tubes are now cut off, so that they reach nearly to the bottom of the flask. They ought to be as narrow as a reasonably fast flow of the liquid from flask to cups will allow. As I could not procure funnels to satisfy me in this respect I shoved a narrow tube through the straight tube, flanging it a little so that it found a support in the conical bottom of the cup, and closed the lower opening of the bent tube partially. Thus, when the air is compressed in the flask the liquid will travel in both tubes with tolerably equal speed. The graduated cup with the straight tube serves for fractional titration, the other one to compare the original colour with the changes of colour produced by the additions from the burette to the graduated cup.

Everything being prepared, I pour 25 c.c. of my normal solution of potassium bromide through one of the funnels into the flask, raise 5 c.c. or ⅕ to the corresponding mark in the cup, close the clamp, and assay in similar manner as described above.

1. I add one drop of the solution of hypochlorite of sodium of unknown strength. A yellowish tint is noticed, faint, but unmistakable. I am allowed to add four more drops. I do so, and observe deepening of the colour with every drop. Having thus spent 0·25 c.c. I am allowed to add 1 c.c. more, or 1·25 c.c. in all. I add 0·25 c.c. at one time, stir, and observe that the colour becomes more intense by stirring. The next 0·25 c.c. do not seem materially to increase the colour, although it does not decrease. Therefore, I add only 0·10 c.c. at one time, note 0·85 as doubtful, observe with the next drop a probable decrease of colour, which decrease becomes more marked with the second drop, and quite decided and unmistakable with the third. I know now that the assay will be finished between $5 \times 0·75 = 3·75$ c.c. and $5 \times 1 = 5$ c.c., probably already $5 \times 0·90 = 4·5$ c.c. I lower the stand in the burette to 3·75 c.c., which makes the contents of the graduated cup nearly as light as those of the other cup, open the clamp, mix and wash the cups as described above. As I know that I am very near the finish, I raise only to the 1 c.c. mark.

2. I add one drop; the 1 c.c. gets quite light compared with its partner in the other cup. I blow now into my rubber tube, open the clamp while blowing in order to prevent the sample from sinking back into the flask, and raise to the 5 c.c. mark. This permits a better observation than adding the drop at once to the 5 c.c. I compare the two colours at my leisure. The result is doubtful. The colour seems to have neither increased nor decreased. The next drop shows a decided decrease of colour on comparing both cups. I cannot go any further with fractional titration, being probably within three drops of the end of the assay. I open the clamp, remove the cork and funnels after washing rod and cups with water, and boil the contents of the flask until the colour has become quite white and no more smell of bromine can be noticed. I cool by water, add one c.c. of chloroform, close the flask with my thumb, shake violently, and observe whether the chloroform has become coloured. If not, as it will not be if all the bromine has been evaporated, I add one drop from the burette and shake as before. In the settled little drops of chloroform (the advantage of a pointed egg-shape of the flask will show now) I recognise distinctly a yellowish tint. The next drop leaves me uncertain if there is any change in colour. The third drop shows without fail an almost complete decolouration. The assay is finished. By deducting the last drop and one-half of the former drop I learn that 25 m.grms. bromine are indicated by 3·925 c.c. of my standard solution. Each drop of 0·05 c.c. will, henceforth, disclose (3·925/0·05 being = 78·5) 25/78·5 or about ⅓ of a m.grm. of bromine. The limits of accuracy depend on: (1) the least possible number of drops for testing by chloroform; (2) the least possible amount of chloroform, that is: (3) the least possible volume of solution, because the more solution the more chloroform must be given to obtain drops of sufficient quantity for a good observation of colour.

The following table will record the results of this assay in a better shape, + expressing increase, − decrease of colour, ? doubtful.

Addition.

	To $\frac{1}{5}$ Made. C.c.		To the Whole. Allowed. C.c.	Forbidden. C.c.	Made. C.c.	Stand of Burette. 0·00 c.c.
No. 1	1 drop = 0·05	+	0·25	—	—	—
	0·25	+	1·25	—	—	—
	0·50	+	2·50	—	—	—
	0·75	+	3·75	—	—	—
	0·85	?	—	—	—	—
	1·00	−	—	5·00	—	—
	—	—	—	—	3·75	3·75
No. 2	0·05	?	—	0·05 } 0·30		—
	0·05	−	—	0·25 }	0·10	3·85
No. 3	—	—	With chloroform:			—
	—	+			0·05	—
	—	?			0·05	—
	—	−			0·05	4·00
	—	—	less the last 1½ drops:			0·057
						3·925

It will be observed that the one dangerous calculation in this titration was the fourth of No. 1, which brought me on a not perfect observation too near to the result. I choose intentionally this example for pointing out the danger of adding too much from the burette on the observation of the first fractional titration, when the second cup contains still colourless liquid and offers no chance for comparison of colours. The increase of colour becomes easily fallacious after a certain intensity has been obtained, but not the decrease. The record of "addition

allowed to the whole" ought to be based on certainty, which may be won by another fractional titration. The following table will explain how the titration ought to have been made:—

Addition.

	To $\frac{1}{5}$ Made. C.c.		To the Whole. Allowed. C.c.	Forbidden. C.c.	Made. C.c.	Stand of Burette. 0·00 c.c.
No. 1	1 drop = 0·05	+	0·25	—	—	—
	0·25	+	1·25	—	—	—
	0·50	+	2·50	—	—	—
	0·75	?	—	—	—	—
	0·85	?	—	—	—	—
	1·00	—	—	5·00	—	—
	—	—	—	—	2·50	2·50
No. 2	0·05	+	0·25	—	—	—
	0·10	+	0·50	—	—	—
	0·20	+	1·00	—	—	—
	0·30	?	—	—	—	—
	0·40	—	—	2·00	—	—
	—	—	—	—	1·00	3·50
No. 3	0·05	+	0·25	—	—	—
	0·10	?	—	—	—	—
	0·15	—	—	0·75	—	—
	—	—	—	—	0·25	3·75

To sum up, this kind of titration is based at the beginning on colouration, and toward the finish on decolouration of the fraction in the cup. As long as three drops are required to produce a decolouration, another fractional titration may be safely undertaken; but when already two drops change the colour decidedly, it is better to stop and proceed to the final test with chloroform. These remarks refer, of course, only to a standard solution of about the strength indicated here.

The titration of the 25 c.c. obtained from the 250 c.c. of sea-water is done in exactly the same manner as that of the normal solution of potassium bromide, except that the observation of the first drop from the burette requires special attention. In the presence of iron (from the zinc) or copper, both being under the circumstances ferrous or cuprous salts, no bromine will be set free until they have been converted by the chlorine into ferric and cupric salts. Therefore, before commencing on the fractional titration, I empty the 25 c.c. into the flask, add 1 c.c. chloroform, also one drop from the burette, shake, and observe whether the chloroform shows colouring. If it does, I evaporate the drop of chloroform by boiling the contents of the flask while keeping them in agitation, cool, return the solution to the graduated cylinder, fill up to 25 c.c., and titrate in the manner described above, adding the one drop from the burette used for colouring the chloroform to the account.

The more experienced analyst will, however, be able to recognise the first colour without requiring chloroform, and thus avoid boiling the solution previous to titration, which may cause a slight loss by evaporating some hydrobromic acid, unless sodium carbonate is added. For the titration, the solution has then to be made acid again. Whilst by this preliminary test traces of iron, manganese, copper, and sulphurous gas can be detected and made harmless, the presence of hyposulphite of zinc (formed by the action of sulphurous gas on zinc) affects the assay more seriously, as it is less readily oxidised, completely only when the titrated solution is boiled to evaporate the free bromine. This causes formation of hydrobromic acid —hence the necessity of guarding against the presence of sulphurous gas before zinc is added. Every analyst will judge what other substances may be present in his solution which might interfere, and how to remove them.

It remains to state that the titration, as described, may also be applied to a solution of zinc bromide and chloride obtained by reducing a precipitate of argentic bromide and chloride by zinc. But more zinc will be required than for the reduction of cuprous bromide and chloride. Argentic nitrate will precipitate 5 grms. of chlorine from 250 c.c. of sea water, while in the precipitate obtained in the manner described there are only 1½ grms. For this reason, and on account of the comparatively large volume of the argentic chloride, it is less easy to obtain a small volume of solution for titration.

Fehling's method of partial precipitation by argentic nitrate, with its difficult settling and sweetening of the precipitate, and absence of a ready test for ascertaining whether the bromine has been completely separated, I leave out of consideration here.

The amount of bromine in the sea-water near the entrance to the Bay of San Francisco, determined in the manner described, is 67·5 m.grms. in one litre.—*Proceedings of the California Academy of Sciences*, 1888.

THE FOUNDATIONS OF CHEMISTRY.*

By T. STERRY HUNT, LL.D., F.R.S.

1. In an essay published forty years since, in September, 1848, the present writer advanced as the "basis of a true natural system of chemical classification" certain views as to elemental and polymeric types which have since played an important part in the science of chemistry. Assuming as the primal or fundamental type, hydrogen, H_2 (of which both water and ammonia were regarded as derivatives), and following the lead of Auguste Laurent, who had already, in 1846, represented alcohol and ether as derivatives of water, H_2O, in which one and two portions of hydrogen respectively are replaced by C_2H_5,† the hydrocarbons methane and ethane were considered as derivatives of H_2, in which one portion of hydrogen is replaced by CH_3 and C_2H_5. The relation between these hydrocarbons and hydrogen, and between the corresponding alcohols and water, was then declared to be one of homology, and these views were subsequently maintained and enforced on many occasions.‡

2. In the same essay the writer insisted on the existence of condensed or polymeric types, the pentachlorides being "referrible to a triple molecule, represented by H_6, while the corresponding trichlorides form a double molecule." The triple molecule was further said to be represented by the vapour of sulphur, then known only in its hexad form, S_6, the anomalous density of which, as compared with that of oxygen, was explained as the result of polymerism or condensation, while a similar condensation was suggested as probable in the case of ozone. The derivation of monobasic acids from the type of water, H_2O, and the possibility of anhydrides of these, and notably of the nitric anhydride (soon afterwards discovered by H. Deville), was also maintained in this essay; while bibasic and tribasic acids were regarded as derived from condensed types corresponding to two and three molecules of water. Hydrogen, H_2, was then both the prototype and the logue of the hydrocarbons and the chlorides, and water, H_2O, of alcohols, ethers, oxacids, and anhydrides.

3. There were thus enunciated in this essay, in 1848, two distinct and important conceptions: (1) Hydrogen, H_2, is the primal chemical type, of which water and ammonia are derivatives, and to which both mineral and so called organic or hydrocarbonaceous types may be referred. (2) Besides this dual or normal type, repre-

* Read before the National Academy of Sciences, April 17, 1888 Reprinted from the *American Chemical Journal*, vol. x., No. 5.

† Being H_2O_2 and C_4H_5 in the notation then in use, in which H=1, C=6, and O=8.

‡ "On some Anomalies in the Atomic Volume of Sulphur, &c., with Remarks on Chemical Classification," *American Journal of Science* (Sept., 1848), vi., 170 to 178; also, "On some Principles to be Considered in Chemical Classification," read before the American Association for the Advancement of Science, Philadelphia (1848). *Ibid.*, 1849, vii., 399; viii., 89 (also, v., 265; ix., 65; xlii., 206); and further, "The Theoretical Relations of Water and Hydrogen" (1854), *Ibid.*, xvii., 194, and *Chemical Gazette*, 1854, p. 181; also, "The Theory of Types in Chemistry" (1861); *American Journal of Science* xxxi., 256, and Hunt's "Chemical and Geological Essays" (pp. 464 to 469).

sented by H_2, there are also condensed or polymeric types, represented respectively by H_4 and by H_6, S_3, &c., the condensation being made evident by the increased density of the polymeric vapours. How the first of these conceptions, that of the typical relations of water and hydrogen, after having been maintained for some years, was at length adopted by Gerhardt, Brodie, and Williamson, in 1851—1852, is to-day a matter of history, and is set forth in the two papers of 1854 and 1861, already cited, in the latter of which will be found quoted a full recognition by Wolcott Gibbs of the writer's claims to priority, The second and not less important conception—that of condensed or polymeric types, as represented by the higher metallic chlorides and the dense vapour of sulphur—remained, however, apparently unnoticed by chemists until after its re-statement in 1854, when it was adopted by Ad. Wurtz.

4. Meanwhile the writer, in the essay already noticed, "On some Principles to be Considered in Chemical Classification" (read in 1848 and published in 1849), had still further considered this conception of polymerism with increase of specific gravity, which was then extended from vapours to solid species, and was illustrated by the allotropic modifications of carbon and of phosphorus. In 1853 an attempt was, moreover, made to show that the change from a gaseous to a liquid or solid species is itself subjected to the same general law of polymerism; while in 1867 it was maintained that vapours, and the liquid and solid products of their condensation, as in the case of steam, water, and ice, are to be regarded as distinct species, the latter two being polymeric or allotropic forms of water vapour; in a word, that all changes of state or condition in bodies are essentially chemical in their nature.* Similar views as to the chemical relations of gaseous, liquid, and solid species were thirty years later, in 1883, set forth by Prof. W. Spring, of Liège,‡ to whom my earlier discussions of the subject were unknown.

Continuing the line of inquiry thus begun, and followed at intervals during forty years, it is now proposed to consider briefly the relations of gaseous, liquid, and solid species to temperature and pressure, together with the phenomena of allotropism, of specific gravity, of hardness, and of chemical indifference; all of which, as we have elsewhere maintained, are intimately related to and dependent upon the principle of condensation then enunciated.

5. All chemical change, of which this polymerism or condensation is but one manifestation, is subordinated to simple relations of weight and volume, which are most evident in the case of volatile and gaseous species. Well-defined gases, such as hydrogen, nitrogen, oxygen, carbon monoxide, and methane, undergo, through a wide range of temperature, a constant regular change of volume, amounting for each degree centigrade to $\frac{1}{273}$ of their volume at 0°. Their coefficient of expansion not being sensibly affected by considerable variations of pressure (which, according to Boyle's or Mariotte's law, the temperature being constant, causes the volume to vary inversely as the pressure), it follows that if we know the weight of a volume of such a gas at any given temperature and pressure, it is easy to calculate what its weight should be at any other temperature and any other pressure; as for example at 0° and 760 m.m., which are assumed as the standards in studying gases and vapours. These regular and constant variations in the weight and volume of a species under changes of temperature and pressure characterise the perfect or ideal gaseous state of matter. This is, however, known to us only within certain limits, since recent experiments have shown that the gases mentioned above are by the combined action of cold and pressure reduced to the state of liquids which, although still more or less compressible, are not subject to Boyle's law, and, moreover, often present great and rapidly increasing coefficients of expansion by heat,—a point especially noticeable in liquids as they approach the critical point beyond which they pass, under great pressure, into dense vapours.

6. The ideal liquid, like the ideal gas, has a regular rate of thermic expansion, the coefficient of which, however, varies for the different species, and is apparently (like its compressibility) closely connected with the degree of condensation; that is to say, with the interval by which it is removed from the normal gaseous species with which it is connected through dense vapours o higher integral weight. Water and mercury are, within considerable ranges of temperature, nearly ideal liquids. The ideal solid is, like the ideal liquid, permanent through considerable ranges of temperature, within which it has a regular coefficient of expansion of heat. It is sometimes more and sometimes less condensed than the corresponding liquid species; thus ice is considerably lighter than water, and solid bismuth is lighter than the fused metal, while in the greater number of cases the solid is heavier than the corresponding liquid species. For such liquids as become denser in solidification, it is well known that pressure augments their temperature of fusion. Amagat, in accordance with this principle, has reversed the well-known experiment of liquefying ice by pressure, and has effected the solidification of carbon dichloride (hitherto known only in a liquid form) by a pressure of 900 atmospheres at 10°; while benzene, which under standard pressure crystallises only at 0°, is solidified at 22° under 700 atmospheres. There is probably, however, according to Amagat, "a temperature above which solidification cannot be effected by any pressure; that is to say, a critical point of solidification, as there is apparently a temperature below which the body remains solid under the feeblest pressure."*

On the other hand, it appears from many experiments that, in the language of W. Allen Miller, "there exists for every liquid a temperature at which no amount of pressure is sufficient to retain it in liquid form."† In other words, all such liquids and solid species, if stable, —that is, not thereby undergoing heterogeneous dissociation,—when heated under sufficient pressure to a temperature which for each is called its critical point, pass, with a comparatively small augmentation of volume, into the condition of very dense vapour or gas. The distinction between liquid and gas just above the critical point is, according to Andrews, impossible, and, in the language of Ramsay and Young, "would also disappear below the critical point, were it possible to follow the continuous change from liquid to gas."‡ In fact, the passage from the perfect or ideal gas proceeds through successively denser unstable polymeric gaseous or vaporous species, often more or less intermingled with one another, and perhaps also through unstable liquid species, into the ideal liquid or the ideal solid species.

7. We assume for the unit of volume in chemistry 1000 c.c., or 1 litre, and for the unit of weight that of this volume of hydrogen at 0° and 760 m.m., which equals very nearly 0·0896 grm., or, according to the determination of Regnault in the latitude of Paris, 0·089578 grm. In hydrogen, which through a wide range of temperature and pressure retains the properties of a perfect or ideal gas, we have a standard of weight upon which is built the stochiometry of modern chemistry. The weight of this volume of hydrogen, at the temperature and pressure named, being taken as unity (H = 1), that of a like volume of oxygen gas under the same conditions is approximately 16, or, more nearly, 15·96; that of nitrogen being 14, and

* "Theory of Chemical Changes and Equivalent Volumes," 1853: *American Journal of Science*, xv., 226; *L. E. and D. Philos. Mag.*, (4), v., 26; and in German translation, *Chem. Centralbl.*, 1853, 849; also, "The Objects and Methods of Mineralogy" (1867), *American Journal of Science*, xiii., 203. These two papers are reprinted in the author's "Chemical Essays," 426 to 437 and 453 to 458. See also "A New Basis for Chemistry," &c., §§ 20 to 22.

† "Sur l'Elasticité parfaite des Corps Solides chimiquement definis." *Bull. de l'Acad. Roy. de Belgique* (2), vi., No. 11.

* *Comptes Rendus de l'Acad. des Sciences*, July 18, 1887.

† Miller, "Chemical Physics," 3rd edition.

‡ *L. E. and D. Philos. Magazine* (5), xiii., 548.

that of chlorine 35·5. If now we bring together, under these conditions of temperature and pressure, 2 litres of hydrogen and 1 litre of oxygen gas, no change takes place until by the intervention of flame or the electric spark, or more slowly by the action of spongy platinum, their union is effected, with dissipation of radiant energy. The product of the integration of the two gases may exist at 0° either as solid ice or as liquid water. This latter at 100°, overcoming the atmospheric pressure of 760 m.m., passes into water vapour, which at higher temperatures is subject to the common law governing the thermic expansion of gases, but at length reaches a point at which at standard pressure it undergoes heterogeneous disintegration, being resolved into its constituent gaseous elements. The weight of a litre of water vapour is the sum of the weights of a litre of hydrogen and half a litre of oxygen, the volume of the latter, as well as the specific characters of both, having in the act of integration been lost in that of a new species, so that the weight of a litre of hydrogen at 0° and 760 m.m. being unity = 1·00, that of a litre of water vapour reduced by calculation to the same standard temperature and pressure = 8·98. But as the combining weight for water vapour—or, in other words, its integral weight—is found to be twice that number, or 17·96, its volume is represented by 2 litres. It is thus, in the language of A. W. Hofmann, dilitral. When, in the older notation, the volume of eight parts of oxygen was assumed as the unit, O=8, water vapour, then written, H_2O_2, was said to consist of four volumes of hydrogen and two of oxygen condensed into four volumes of vapour.

(To be continued).

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending September 30th, 1888.

By WILLIAM CROOKES, F.R.S.;
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To General A. De Courcy Scott, R.A.,
Water Examiner, Metropolis Water Act, 1871.

London, October 6th, 1888.

Sir,—We submit herewith the results of our analyses of the 175 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from September 1st to September 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The analyses of the waters of the past month show them to have been of high quality, a manifest reduction in the dissolved organic matter being apparent. Thus, during August, the average oxygen required per gallon for the Thames-derived waters when examined by the oxygen process was 0·071 grain, whilst for September it was 0·043 grain. In like manner the organic carbon shows a reduction from 0·120 grain per gallon in August to 0·104 grain in September. The unusual meteorology of the Summer, referred to in a previous report, has had its influence (as we should have expected) on the character of the waters. They have, however, throughout been of excellent quality.

Of 175 samples examined during September, 165 were found to be absolutely free from any trace of visible suspended matter.

We are, Sir,
Your obedient Servants,
William Crookes.
William Odling.
C. Meymott Tidy.

CORRESPONDENCE.

NOTE ON A NEW TEST FOR IRON.

To the Editor of the Chemical News.

Sir,—In the article appearing under this heading in this week's issue of the Chemical News (vol. lviii., p. 170), transcribed from the *Journal of Analytical Chemistry*, it is stated that the blue solution produced by the addition of strong hydrochloric acid to a cobalt salt becomes green in the presence of a trace of a ferric salt, of which 0·03 m.grm. can be thus detected.

I find that the presence of cobalt is needless, as the well-known yellow colour produced by the addition of strong hydrochloric acid to a ferric salt is quite distinct at this degree of dilution. Further, it is stated that the green colour is probably not due to the mere mixing of the blue and yellow solutions, for other yellow solutions fail to give the green. This I cannot endorse, as I obtained the green colour using such diverse yellows as platinic chloride and potassium bichromate.

I may mention that strong hydrochloric acid is an extremely delicate test for cobalt itself, I having detected a minute trace in a sample of tin by its means.—I am, &c.,

Bertram Blount.

ANALYSIS OF FERTILISERS.

To the Editor of the Chemical News.

Sir,—I am at present working on the above subject, and as Mr. Firby (Chemical News, vol. lviii., p. 170) has drawn attention to the high results obtained in estimating phosphate of lime by the magnesia method, I would like now to give a few of my preliminary results on this branch of the investigation, instead of waiting until it is finished.

The dissolved manures which the experiments were carried out on were manufactured from Curacao, Aruba, Canadian, Carolina, and Belgian phosphates, bones, and a variety of ammoniated materials, and in all these cases my experience goes to show that either there is no silica soluble in hydrochloric acid or in water, or, what comes to much the same thing, it has no effect on the phosphate determination.

The experiments this is based upon are as follows:—

1. 50 grains pyrophosphate of magnesia, obtained from estimations of "soluble phosphate," was treated with hot dilute hydrochloric acid, boiled, the insoluble residue filtered off, washed, and ignited; it weighed 0·03 grain.

2. 110 grains obtained from estimations of "total phosphate" treated in same manner gave 0·15 grain insoluble residue.

When one remembers that there was some of the filter-ash left in the precipitates, these figures do not leave much room for silica, and no chemist will deny that if there had been any silica precipitated it would have become insoluble in dilute hydrochloric acid.

Fresenius points out ("Quantitative Analysis, 7th Ed., page 366) that it is not safe to evaporate a hydrochloric

acid solution of a phosphate to complete dryness, as pyrophosphoric acid is formed at temperatures below 150° C. Has Mr. Firby remembered this when he got a difference of 4½ per cent?

It *may* be that in some rare cases there is soluble silica enough to give results so much above the truth, but I am perfectly satisfied it is not in a fertiliser made from any of the raw materials mentioned.

Mr. Firby's letter is apt to lead one to the conclusion that the majority of estimations of soluble and total phosphate are by far too high, and thus tells very sorely and unfairly against the manufacturer, as the above two experiments show—at least, so far as my firm's articles are concerned.—I am, &c.,

ALEX. BUCHAN, F.I.C.

Port Dundas Chemical Manure Works,
Glasgow, Oct. 11, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed

Moniteur Scientifique, Quesneville.
Series 4, Vol. ii., August, 1888.

The Hermite Process of Electrolytic Bleaching.—C. F. Cross and E. J. Bevan.—From the *Journal of the Society of Chemical Industry.*

Manufacture of Cement with Lime Mud (Rigby's Process).—J. S. Rigby.—From the *Journal of the Society of Chemical Industry.*

On Levulose.—A. Herzfeld.—From *Liebig's Annalen.*

On the Limited Sensitiveness of Indicators and on Some Qualitative Reactions. — E. Dietrich. — The author shows that for sulphuric and hydrochloric acids blue litmus, and still more blue alkanet, are more sensitive than tropeolin and Congo red. For potassa the most delicate reagents are red alkanet and logwood. For ammonia the same two reagents and rosolic acid take the first rank.

The Isomers of Tannic Acid.—Hugo Schiff.—From *Liebig's Annalen.*

The Proportion in which Chloride of Lime Loses its Active Chlorine if Kept at Different Temperatures.—John Pattinson.—From the *Journal of the Society of Chemical Industry.*

Recovery of Sulphur from Alkali Waste by Means of the Gases from Lime-kilns.—Alexander Chance.—From the *Journal of the Society of Chemical Industry.*

Saccharine or Coal-tar Sugar. — Ch. Girard. — Passages are quoted from Dr. Fahlberg, in which he evidently contemplates the use of saccharine as a means of enabling glucose to be passed off as cane-sugar. The important fact is mentioned that bees, flies, &c., refuse to taste saccharine, and even avoid it. A burlesque patent specification by a Dr. Fahlhrügel, of Reklamendorf (or, in English, "Puffingthorpe"), appears in a supplement to the Berlin *Berichte.* It is proposed to recover saccharine n great cities by collecting the excreta, extracting them with petroleum ether, and distilling off the liquid.

Report to the Prefect of Police on the Introduction of Saccharine into Alimentary Matters. — Dujardin Beaumetz.

Analysis of Nitrogen Chloride.—Dr. Gattermann.—The formula resulting from the author's analysis is NCl_3. The compound may be violently exploded by the action of the sun or of the magnesium light, but it never explodes in darkness or on gloomy days.

Industrial Society of Mulhouse.—Session of April 11.—M. Paul Werner sent in a paper on the colouration of aniline if exposed to the air, which he finds is due to an absorption of oxygen under the influence of light.

Session of May 9.

A discussion took place on the priority of L. Schwartz as the inventor of garanceux, a matter which has no longer any practical interest.

Extraordinary Session, May 23.

M. Maurice Prud'homme sent in an account of a tartar emetic resist under tannin aniline steam-colours. This communication should have been made in July or September, 1881.

Session of June 13.

The Committee was engaged in revising the list of prizes to be offered.

A New Series of Colouring-matters for Cottons.—A. G. Green.—From the *Journal of the Society of Chemical Industry.*

The Action of Sulphur and Chloride of Sulphur on Oils.—T. Bruce Warren.—From the CHEMICAL NEWS.

Pressure-Tubes, their Use and Construction.—H. Warren.—From the CHEMICAL NEWS.

The Compounds of Ammonia with Selenium Dioxide. — C. Cameron and J. Macallan. — From the CHEMICAL NEWS.

Iodide of Starch.—H. Stocks.—From the CHEMICAL NEWS.

Zeitschrift fur Analytische Chemie.
Vol. xxvii., Part 4.

Determination of Nitric Acid.—Dr. H. Wilfarth.—This memoir cannot be reproduced without the accompanying illustrations.

Determination of Sugar in Liqueurs, Confectionery, and Chocolate.—F. Rathgen.—The first test to be applied to a liqueur or an article of confectionery is to heat the aqueous solution with a little copper sulphate and soda-lye. If there is no precipitate of cuprous oxide, or but a slight one, we may polarise at once. In the presence of appreciable quantities of inverted sugar or glucose the inversion process of Clerget is recommended. Many kinds of confectionery require special procedures. The solutions must generally be decolourised with aluminium hydroxide and charred blood. In gum lozenges the sugar cannot be determined by a polaristrombometric process, since the optically active gum cannot be completely separated by means of alcohol. In "caramels" an accurate determination of saccharose is not practicable, as glucose is present to the extent of about 16 per cent.

Determination of Sulphur in Cokes.—L. Blum.—Already noticed.

Determination of Fatty Matter in Linseed Cake.—R. Klopsch.—In a linseed cake containing 11 per cent of fat two successive analyses gave only 4·5 and 4·8 per cent. In searching for the cause the author found that prolonged desiccation with heat renders the fatty matter insoluble in ether. The author recommends that the drying process should not be prolonged beyond three hours.

Concluding Remarks on the Application of the Knop-Wolf Method in the Analysis of Soils.—Dr. A. Baumann.— The author recommends all chemists who are not yet convinced of the worthlessness of the Knop-Wolf process to apply it carefully and exactly, as prescribed by Knop, to three lots of soil, one of 200 to 300 grms., the quantity which Knop formerly used and recommended, one of 100 grms., which Knop now thinks the proper quantity for use, and one of 10 grms.

Qualitative Separation of Gold and Platinum from Arsenic, Antimony, and Tin.—Dr. L. L. de Koninck and Dr. A. Lecrenier.—Already inserted.

Determination of Carbon in the Irons of Commerce.—L. L. de Koninck.—Already inserted.

Determination of Fat in Milk and Cream.—Dr. Werner Schmid.—The author takes a test-tube of about 50 c.c. capacity, graduated in tenths of a c.c., introduces 5 c.c. of cream or 10 c.c. of milk, accurately measured, adds 10 c.c. of strong hydrochloric acid, boils, with shaking, until the liquid turns dark brown, cools by placing the tube in cold water, adds 30 c.c. of ether, shakes round, lets stand, measures the volume of the ethereal solution, draws off 10 c.c. with a pipette, evaporates down in a weighed porcelain capsule on the water-bath, and finally in an air-bath at 100°. He then weighs and calculates for the original quantity of the ethereal solution. If the process has been rightly conducted the ether separates from the aqueous solution clear, without the slightest turbidity. The ethereal solution, as it flows out of the pipette, should not show any watery drops. The results are perfectly accurate, and differ from each other and from the ordinary gravimetric methods by less than one-tenth per cent. The operation requires at most fiteen minutes.

An Aspirator with Constant Outflow.—Otto Binder.—This paper cannot be reproduced without the accompanying figures.

Safety-Retort for the Preparation of Gas.—N. von Klobulow.—This memoir also requires the accompanying illustration.

Molnar's Equably-working Suction Apparatus.—Von Klobulow.—The author shows that Molnar's apparatus is in principle identical with his own "Air-pump Regulator, described in *Zeit. f. Anal. Chem.*, xxiv., p. 399.

Two Measuring Instruments with Patent Cocks.—Greiner and Freidrichs.—Unintelligible without the three accompanying figures.

Official Proclamation on the Examination of Colours, Yarns, and Tissues for Arsenic and Tin.—An account of the methods for such investigations which are now legally compulsory in Germany. The processes given will be inserted as early as possible.

The Vapour-tension of Mercury.—W. Ramsay and Sidney Young.—From the *Journal of the Chemical Society*.

The Absorption of Watery Vapour from Moist Air by Solids.—T. Ihmori.—Metal coated with shellac varnish takes up much moisture, but little water is precipitated upon burnished metal. Oxidised metallic surfaces take up relatively much water and lose it again only partially in dry air. Rock crystal, if properly cleansed, takes up little water. Platinum, if cleansed with leather. absorbs no water. Hence the metallic parts of balances should be platinised wherever possible; the use of shellac varnish is very disadvantageous. The use of agate in the beams of balances should be avoided.

Simplification of the Calculation of Analyses.—E. A. Uehling.—The author proposes that as many grms. of the substance in question should be taken as the precipitate to be weighed contains per cents of the compound to be obtained.

On the Corrections of Analyses.—W. A. Dixon.—From the Chemical News.

The Incineration of Organic Matter.—Processes devised by Alex. Köbrich and H. Kronberg, and both taken from the *Chemiker Zeitung*. The Kronberg process is as follows:—In order to incinerate substances which, during incineration, swell up strongly like sugar or deflagrate slightly or give off dust like the salts of the organic nitro-acids, the author weighs off a portion of the pulverised sample in a glass tube which can be stoppered, and transfers it to the platinum crucible in such small portions that no tumefaction or dispersion of ashes can take place. The crucible contains, as a stirring-rod, a short thick straight platinum wire, which projects above the edge of the crucible only so far that it may be grasped, passes through a very small lateral opening in the edge of the lid, and is weighed along with the crucible and lid. The charge is ignited, the crucible being covered, beginning at the side, and continuing to ignite with the crucible placed in a slanting position. The ash is crushed, if necessary, with the platinum rod, the crucible is let cool, and a further portion of the substance is added and treated as above. When a sufficient quantity of the ash has thus collected, the entire mass is ignited at a higher temperature. For the completion of the incineration, if nitric or sulphuric acid is inadmissible, the crucible is let cool down to about the boiling-point of water, and so much water is added drop by drop along the side of the crucible that on stirring with the wire all the soluble salts are dissolved. Any carbonaceous matter remaining is brought to the sides of the crucible, the small quantity of water is cautiously evaporated away, and the whole is re-ignited.

Incineration of Coke and Graphite.—Fr. Stolba (*Listy Chemicke*) recommends the addition of silver powder, prepared by the reduction of silver chloride in the moist way. Finely ground graphite or coke is mixed with an equal weight of pulverulent silver and heated to redness in a platinum crucible. Fusion of the silver must be avoided. In this manner the combustion is very rapidly effected.

Viscosimeter.—S. M. Babcock.—From the *Journal of Analytical Chemistry*.

Influence of Organic Bodies upon Iodometric Determinations.—J. Klaudie (*Listy Chemicke*).—Fatty acids and sugar have no effect. Aldehyds, phenols, gallic and tannic acids consume considerable quantities of sugar. This circumstance must be remembered in the examination of waste waters.

The Methods of the Mechanical Analysis of Soils.—T. B. Osborne.—From the *Journal of Analytical Chemistry*.

The Structure and Use of Scientific Balances.—G. Schwirkus, Th. Thiesen, and A. Springer.—These papers are merely mentioned.

Determination of the Specific Gravity of Large Solids.—O. Kleinstuck.—The author proposes as pyknometer a wide cylinder with a polished edge, closed with a glass plate, ground to fit.

International Areometer.—F. Spence.—From the Chemical News.

Prevention of the Regurgitation of Absorbent Liquids.—K. J. Bayer (*Chemiker Zeitung*).—For this purpose the author connects the generator with the absorbent vessel by means of a bulb-tube drawn out to a capillary at its exit end.

Apparatus for the Detection of Small Quantities of Carbonic Acid.—O. Rössler.

A Mill for Comminuting Minerals for Analysis.—K. Zulkowsky.—Both these papers require the accompanying figures.

Wanted, Second-hand Ironwork for Pyrites (lump) Burners—must be in good condition.—Address, with sketch, stating price, to Box 888, Chemical News Office, Boy Court, Ludgate Hill, London, E.C.

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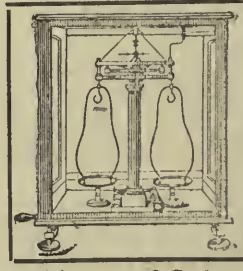

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1509.

ON A NEW MIXTURE FOR SEPARATING CARBON FROM PIG-IRON, STEEL, &c.

By T. W. HOGG.

The most accurate methods that have been proposed for the determination of carbon in steel, pig-iron, and other ferro-carbon alloys, are those in which the carbon is first separated in a state of proximate purity, and afterwards burnt in a current of oxygen.

In order that this separation may be effected it is simply necessary to treat the particular ferro-carbon alloy with some salt whose base can either be substituted entirely, or where the salt can be reduced to some lower compound by the iron present in the alloy; the carbon not taking any part in the reaction is left behind as such, and may be filtered off for further treatment.

It is obvious that quite a considerable number of salts are capable of effecting this separation, and a great many have been recommended for the purpose, but none of them have given such general satisfaction as a neutral solution of cupric chloride. However, even this cupric chloride possesses one objectionable quality,—the decomposition of the alloy is accompanied by the production of cuprous chloride, and, as this is comparatively speaking an insoluble compound, it is necessary to provide against its precipitation: this is accomplished by adding an abundance of concentrated hydrochloric acid, or by having present in great excess a saturated solution of some salt such as sodium or ammonic chloride.

Whatever plan may be adopted, this insolubility of the cuprous chloride is always troublesome, and occasionally proves an intolerable nuisance; and it is the object of this short paper to draw attention to a reaction familiar to every chemist by means of which this inconvenience may be entirely removed.

When a solution of ferric chloride is added to cuprous chloride an immediate change takes place, cupric chloride and ferrous chloride being formed.

The ferric chloride solution may be utilised in different ways by the operator; he may conduct the analysis by means of cupric chloride as usual, and at the end decompose the cuprous chloride by adding sufficient ferric chloride, or he may add this salt as soon as the mixture of metallic copper and carbon is obtained. A little gentle heating, aided by a few drops of hydrochloric acid, will suffice to cause the whole of the metallic copper to be dissolved by the ferric chloride.

The ferric chloride may be used in a still more advantageous and economical point of view; it will itself, as is well known, decompose most ferro-carbon alloys, but not without some loss of carbon; but if a small proportion of cupric chloride be present this loss is entirely prevented. The decomposition proceeds entirely through the medium of the copper salt, which is at first reduced and then reformed at the expense of the ferric chloride.

The ferric chloride should possess a sp. gr. of about 1·30, and the copper salt 1·35, but so long as these solutions are kept pretty concentrated the exact strength is not a matter of very great consequence; a little ammonium hydrate should be added to neutralise any excess of free acid that might be present. The ferric chloride will dissolve ferric hydrate long after all free acid is neutralised, so that it is best to try the mixture with a high carbon steel, and ascertain whether there is any indication of the evolution of hydrocarbons.

After weighing the requisite quantity of the alloy, and placing it in a beaker, sufficient cupric chloride is added to cover the borings to the depth of about half an inch, and then a considerable excess of the ferric chloride solution is added; after about five minutes' stirring the beaker is placed upon a lamp and heated gently up to boiling-point, and if the borings have been in the proper state of fineness the decomposition will be completed within twenty minutes, and, after adding a few drops of hydrochloric acid, to prevent the precipitation of basic compounds, the carbonaceous residue may be filtered off, and washed prior to further treatment.

In dealing with alloys containing silicon up to about 4 per cent, the carbon should always be filtered off as soon as the alloy is quite decomposed; it is a common occurrence to allow the borings and the cupric chloride to stand all night, and, if this is done, the silicic acid which results from the oxidation of the silicon, and which at first passes almost entirely into solution, is often partially precipitated in the gelatinous condition, with the result that the filtration becomes very tedious.

Newburn Steel-Works,
near Newcastle-on-Tyne.

ON A CERIUM SALT OF CHINOLINE.

By GREVILLE WILLIAMS, F.R.S.

I have shown in my "Researches on Chinoline and its Homologues,"* and "Researches on Isomeric Alkaloids,"† that β-lutidine and chinoline form double salts with gold, copper, cadmium, uranium, platinum, and palladium, and I find that they do so with some of the metals of the cerite earths. Didymous sulphate forms a double salt with β-lutidine, but I have not yet succeeded in obtaining the corresponding lanthanous salt. The didymium salt is not easily prepared in a state of purity. The most beautiful double salt of the cerite earths that I have seen is that formed with nitrate of chinoline and ceric nitrate. On mixing moderately concentrated solutions of the two salts, glittering orange-red rhombic plates of the double nitrate of cerium and chinoline form at once. The salt may be obtained in superb crystals by slow evaporation of a dilute solution. The alkaloid from cinchonine, and that prepared synthetically by Skraup's process, give products similar in appearance. The air-dried salt is anhydrous. The ceric nitrate used was prepared from oxide which had been separated from lanthana and didymia by fusion with nitre. On heating the double salt it fuses readily, giving off red fumes and a powerful odour of nitrobenzol. This last fact is interesting, and reminds us of Dewar's transformation of chinoline into aniline. Great care has to be taken in determining the ceric oxide by ignition of the double salt, as it is liable to deflagrate; and it is better to mix the salt previously with a known weight of sulphate of barium or silica. Even with this precaution I have met with considerable variations in the estimations. The following numbers were obtained on analysis.

I.	0·2955 grm.	gave 0·0654 grm.	ceric oxide.	
II.	0·5547	„ 0·1257	„	„
III.	0·4581	„ 0·1050	„	„
IV.	0·5972	„ 0·1364	„	„
V.	0·5145	„ 0·5288 CO_2 and 0·1040 H_2O.		

or, per cent—

	I.	II.	III.	IV.	V.
Carbon ..	—	—	—	—	28·03
Hydrogen..	—	—	—	—	2·25
Nitrogen ..	—	—	—	—	—
Oxygen ..	—	—	—	—	—
Cerium ..	18·00	18·44	18·66	18·60	—

agreeing with the formula $Ce(NO_3)_4.(C_9H_7N.HNO_3)_2$, as

* *Trans. Roy. Soc. Edin.*, xxi., Part 3.
† *Proc. Roy. Soc. Lond.*, xiii., 303.

will be seen on comparing the mean of the results with the theoretical numbers :—

	Mean.	Calculation.		
Carbon . ..	28·03	27·96	C_{18}	216·0
Hydrogen ..	2·25	2·07	H_{16}	16·0
Nitrogen ..	—	14·50	N_8	112·0
Oxygen . ..	—	37·28	O_{18}	288·0
Cerium . ..	18·43	18·19	Ce	140·5
		100·00		772·5

The ceric oxide obtained in the above determinations was always of a rich orange colour when hot, and yellow with a faint apricot tint when cold.

A CRYSTALLINE SUBSULPHIDE OF IRON AND NICKEL.

By J. B. MACKINTOSH,
Lehigh University, South Bethlehem, Pa.

Some months ago I received a sample of a highly crystalline product occurring in the hearth of the shaft-furnace used in smelting the roasted nicoliferous pyrrhotite at Mr. Joseph Wharton's Works, near the Gap Mine, Lancaster County, Pa.

Mr. Wharton first observed this product in cavities in the concretions in these furnaces about the year 1870, and published a description of it in that year.* Thinking that it might show some analogy to meteoric iron he sent the present sample to Mr. George F. Kunz, who turned it over to me, with the request that I should analyse it at my convenience. The results do not show the expected analogy, because the sulphur in meteoric iron is combined as FeS, while in this product there is only one-sixth the necessary amount of sulphur, which, however, seems to be combined with all the metallic elements present, forming a subsulphide of definite composition. I am informed by Mr. Wharton that he has had for a long time the sample which I have analysed, and that it probably is about the same age as that which he first described. It is worthy of note that the material does not show any signs of oxidation, but that the crystals preserve a brilliant metallic lustre.

The first two analyses, made by Mr. J. Voigt, are those given by Mr. Wharton in his paper above referred to; the third is the analysis I have just completed.

	Voigt. Octahedral crystals.	Granular mass.	Mackintosh. Cubical crystals.
Cu	1·85	1·74	2·20
Ni, Co ..	25·22	28·20	26·16
Fe	64·10	62·50	61·685
S	8·90	7·60	8·305
SiO_2	—	—	0·56
	100·07	100·04	98·91

Theoretical for Fe_4Ni_2S.

Ni	31·29
Fe	60·12
S	8·59
	100·00

In my analysis there is a small amount of silica which is present in mechanical admixture, in the form of slag or furnace-lining. The deficiency in the analysis is due to the other constituents of this admixture. In the granular mass the sulphur is deficient; but as it *was* a granular mass, on which the octahedral crystals were imbedded, it could not be expected to be a definite compound. In the case of the other two analyses, however, both made on crystalline material of approximate purity, the results are quite accordant, and agree with a compound of the general formula R_6S. The ratio of the metals is, roughly, two of iron to one of nickel and copper, and it will be seen, from the theoretical composition which I have calculated on that assumption, that the results of analysis do not vary very much from those calculated.

From a chemical standpoint this compound is of great interest, as it distinctly illustrates the hexatomic character of sulphur, and to the best of my belief is the only known sulphide of similar composition. The manner of occurrence is in small cubical crystals, forming fern-like aggregations, in the cavities in the concretions in the furnace-hearth.

I think it is quite probable that analogous compounds will be formed in copper-smelting; and I would be pleased to receive samples of any similar product from anyone whose attention may be directed to this note.—*Transactions of the American Institute of Mining Engineers.*

* *American Journal of Science*, vol. xlix., p. 365, "On Two Peculiar Products in the Nickel Manufacture."

REPORT OF THE COMMITTEE ON INDEXING CHEMICAL LITERATURE.*

The Committee on Indexing Chemical Literature respectfully present to the Chemical Section its Sixth Annual Report.

By the liberality of the Association the Committee secured 500 copies of the Report for 1887, and these were distributed through the Secretaries of the American Chemical Society, the London Chemical Society, and the Washington Chemical Society, and directly by the Chairman of the Committee. The Provisional List of Abbreviations of Titles of Chemical Journals which formed Appendix B to the Report was received by chemists with general approbation, and was reprinted in the *Proceedings of the American Association for the Advancement of Science*, Chemical News (London), *American Chemical Journal* (Baltimore), *Journal of Analytical Chemistry* (Easton), *Journal of the American Chemical Society* (New York), and was favourably noticed in the *American Journal of Science* (New Haven): this practically ensures its adoption.

During the year just closed the "Index to the Literature of the Spectroscope," by Dr. Alfred Tuckerman, has been published by the Smithsonian Institution. This forms a work of about 400 pages, and contains 3829 titles by 799 authors.

"The Table of Specific Gravities for Solids and Liquids," by Prof. F. W. Clarke, is now in the compositor's hands, and will soon be published by the Smithsonian Institution. This work is really a new and completely revised edition of Part I. of the original "Constants of Nature."

An "Index to the Literature of Columbium," by Prof. Frank W. Traphagen, has been completed and accepted by the Committee, who recommend its publication by the Smithsonian Institution.

Dr. H. C. Bolton has compiled a "Bibliography of Chemistry for 1887," which is also in the hands of the Smithsonian Institution.

Several chemists project indexes, and have made more or less progress on them. Mr. Arthur A. Noyes is engaged on an Index to the Literature of Ethylene; Prof. William P. Mason volunteers to index Methane; Mr. William Rupp undertakes to index Cæsium and Rubidium; Prof. Traphagen plans to index Tantalum; Dr. H. C. Bolton has in preparation a "Bibliography of the History of Chemistry, including Biography and Bibliography"; and Dr. Alfred Tuckerman is engaged in indexing the literature to Thermo-dynamics.

Several bibliographies merit brief mention: Dr. Jesse P. Battershall's "Food Adulteration and its Detection"

* From advance sheets of *Proceedings of the American Association for the Advancement of Science*, Cleveland Meeting, August, 1888.

(New York, 1887) contains an Appendix with the title—"Bibliography including Periodicals, Reports, and General Works chronologically arranged." This includes about 275 titles. The "Second Annual Report of the N. Y. State Dairy Commissioner" (1886) contains a Bibliography of Milk, by Mr. Edward W. Martin (pp. 156 to 170), and a Bibliography of Butter, adulterations, testing, &c., by Prof. Elwyn Waller, assisted by E. W. Martin and others (pp. 283 to 290).

Brof. Wm. H. Seaman calls the attention of the Committee to several lists of United States Patents which relate more or less to applied chemistry. These lists on subjects indicated by their titles are found in the following works:—Charles Thomas Davis, "Manufacture of Leather"; the same, "Practical Treatise on the Manufacture of Bricks, Tiles, and Terra Cotta"; the same, "Treatise on Steam Boiler Incrustations"; the same, "Practical Treatise on the Manufacture of Paper"; Wm. T. Brannt, "Treatise on Animal and Vegetable Fats and Oils." These are all published in Philadelphia, 1884 to 1887.

B. Tollens's "Handbuch der Kohlenhydrate" (Breslau, 1888) contains about 1500 references to the literature of carbohydrates.

Dr. Albert Brown Lyons publishes, in the *Pharmaceutical Era*, under the title "Index Pharmaceuticus," a monthly list of books on pharmacy, chemistry, and materia medica, as well as a list of original papers on these topics published in journals.

At the meeting of the British Association for the Advancement of Science held in 1886 a Committee was appointed for the purpose of reporting on the Bibliography of Solution. This Committee consists of Profs. Tilden, McLeod, Pickering, Ramsay, Young, A. R. Leeds, and Nicol (secretary), and presented its first report in 1887. This report sets forth the classification adopted, the list of journals (thirty-four in number) desirable to index, and a summary of work accomplished. From this summary it appears that 355 titles have been catalogued from 588 volumes of eleven different periodicals.

The Committee of the B. A. recommend to members of the Committee other gentlemen who have access to the journals on the list, and who would be willing to take an active share in the work.

The Committee of the American Association expresses its gratification that the work begun by them in 1882 is now being supplemented by chemists in England.

Persons desiring copies of reports, indexes, and other information, should address the Chairman, care of the Smithsonian Institution, Washington.

H. Carrington Bolton, *Chairman.*
F. W. Clarke.
Albert R. Leeds.
Alexis A. Julien.
John W. Langley.
Samuel H. Scudder.
Chas. K. Wead.

AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The formation of the Association was first suggested by Prof. Liversidge, of the Sydney University, during the Exhibition in Sydney in 1879, but matters at that time not being considered quite ripe for it, the formation of the Association was again brought forward through the press in the year 1884. It was then suggested that, as it was unlikely the British Association would see its way to visit Australasia during the centennial year, an Australasian Association should be formed on the same lines as the parent Association, in order to bring about a federation or union of the members of the various scientific societies throughout Australasia.

It was also suggested that the First General Meeting should be held in Sydney on the One Hundredth Anniversary of the Foundation of the Colony, as it was at that time thought there would be an International Exhibition in Sydney to celebrate that event.

In furtherance of the project a preliminary meeting of Delegates from various scientific societies was held in Sydney in 1886 (November), the project having thus early met with the approbation and support of the majority of the learned and scientific societies of Australasia.

At this meeting the formation of the Australasian Association for the Advancement of Science was agreed to unanimously, the Rules of the British Association being adopted until the First General Meeting, which it was decided should be held in Sydney during 1888, the Centennial Year.

In accordance with another resolution passed at the meeting of Delegates, the election of officers for the year 1888 took place in Sydney in March of the present year:—Mr. H. C. Russell, B.A., F.R.S., Government Astronomer of New South Wales, being elected President, Sir Edward Strickland, K.C.B., F.R.G.S., Hon. Treasurer, and Prof. Liversidge, M.A., F.R.S., and Dr. George Bennett, F.L.S., Hon. Secretaries.

The formation of the General Council was afterwards proceeded with, each society electing one representative for every hundred of its members, and the Chief Justice and Minister for Public Instruction of New South Wales, the Chancellor and Vice-Chancellor of the Sydney University, the Mayor of Sydney, and the Presidents of the Royal Societies of the various colonies were elected Vice-Presidents for the year.

The Presidents of Sections were then elected, the gentlemen chosen being all resident in other colonies than New South Wales, whilst the Secretaries of Sections, as a matter of necessity, were elected from amongst residents in Sydney.

In all about 8000 invitations to join the Association were sent out to members of the various learned and scientific societies, professions, &c., and practically every society coming within the scope of the Association has one or more representative on the General Council.

The Association is thoroughly Australasian in its character and members, and the succeeding General Meetings are to take place in turn in the capitals of the other colonies, the executive officers being elected year by year by the colony in which the meeting is held. It has been decided, however, that Sydney shall be the permanent headquarters of the Association, and that Professor Liversidge shall be the permanent Hon. Secretary.

The First General Meeting was held at Sydney University, the opening ceremony, at which His Excellency the Governor delivered a speech, taking place on Tuesday evening, August 28, when the Presidential Address was delivered.

On the following day the Sectional Meetings commenced, and all the Sections, with one exception, brought their proceedings to a close with the end of the week.

About 110 papers were sent in by gentlemen of distinction in the various branches of science, literature, and art in the different colonies, and a considerable number of the papers are to be published in full in the first volume soon to be issued by the Association.

It may, therefore, be anticipated that the work done by the Association during the first year of its existence is of a highly important and useful character.

The more solid work of the meeting was lightened by excursions to various places of interest to geologists, botanists; and others, and every effort was made to provide for the entertainment and comfort of visiting members, numerous entertainments being given by leading citizens.

The various steamship companies arranged to convey members proceeding to Sydney to attend the meeting at a reduction of 20 per cent in the ordinary rates, and the Government Railway authorities of New South Wales,

Victoria, and South Australia issued return tickets at single rates.

A considerable number of members attended the meeting, and included amongst the visiting members were the leading scientific representatives of each colony.

It has been decided that the next meeting shall be held in Melbourne, and Baron Sir Ferdinand von Müeller, the Government Botanist of Victoria, is the President elect for the year. In 1890 the Association is to meet in New Zealand.

The rules, as already mentioned, are practically the same as those of the British Association, and at the time of the meeting the new Association numbered about 850 members. It is confidently anticipated that this number will be considerably augmented, if not actually doubled, by the time the next General Meeting is held.

THE ESTIMATION OF QUININE BY KERNER'S METHOD.

By EDSEL A. RUDDIMAN.

Within the past few years unusual attention has been given to the examination of the sulphate of quinine for the other alkaloids which occur with it in cinchona barks, more especially cinchonidine. In this examination the method of Dr. Kerner, first published in 1862, has been adopted by the pharmacopœias of Germany, France, and the United States. The pharmacopœia of Great Britain adopts the first principle of Kerner's test—the removal of the excess of quinine by its crystallisation as sulphate—and then resorts to separation of free alkaloids by ether. Notwithstanding the general and official use of Kerner's operation to fix the quality of a medicinal agent of the first importance, this method is still open to questions of criticism, questions to be answered only by a course of investigation. The work undertaken by the writer has been devoted to determinations as follows:—

(1) As to the effect of an initial digestion of the medicinal sulphate of quinine in water at 100° C., followed by the digestion at 15° C., in comparison with results obtained by digesting at once at 15° C.

(2) As to the effect of variations in the temperature of the liquid during titration on the amount of ammonia necessary to re-dissolve the precipitate, filtration being always done at 15° C.

(3) As to the accuracy of Kerner's figures for the amount of ammonia water, sp. gr. 0·920, required to dissolve one m.grm. of cinchonidine sulphate.

(4) A proposed modification of the method for the quantitative estimation of cinchonidine sulphate in quinine sulphate.

(5) On the amount of water which should be taken in applying Kerner's test to salts of quinine other than the sulphate.

(1) *The Effect of Digesting Medicinal Quinine Sulphate at Different Temperatures.*—In an article published in 1877, Paul* called attention to the fact that, in the application of Kerner's test for the detection of cinchonidine sulphate in quinine sulphate, all of the cinchonidine is not dissolved. Since then, and more especially within the last few months, several writers as Paul†, Yungfleisch‡, the committee for the revision of the French Codex,§ Hesse,‖ Kerner,¶ and others have acknowledged that there is truth in this statement. The reason given is that, in the manufacture the sulphates of quinine and cinchonidine crystallise together. The amount of water of digestion being insufficient to dissolve all of the quinine, the cinchonidine is not all dissolved. The French Codex now directs that the digestion take place in hot water, while Yungfleisch advises that the temperature of the water used be 100° C. This undoubtedly makes the test far more severe, but even at 100° C. there is an insufficient amount of water to dissolve all of the quinine.

In testing the commercial salt I have made a modification of the U.S. Ph. method, and in so doing have attempted to make it such that, on an average, those samples of quinine which are included by the officinal test will be included by this modification, and those samples which are excluded by the officinal test will be excluded by this modification. It is as follows:—Take one grm. of the salt and dissolve in 30 c.c. of boiling water (this being enough to dissolve it), cool and digest at 15° C. for two hours, and filter. To 5·26 c.c.* of the filtrate add 7 c.c. of water of ammonia, sp. gr. 0·960, and a clear solution should be obtained. To determine the amount of filtrate which should be taken, I proceeded as follows:—One grm. of the salt was digested with 10 c.c. of water at 15° for three hours and filtered. To five c.c. of the filtrate, ammonia water, sp. gr. 0·960, was added from a burette until the precipitate was just re-dissolved and the amount† used was noted. One grm. of the same sample was dissolved in 30 c.c. of boiling water, the solution cooled, digested at 15° C. for three hours, and filtered. To five c.c. of the filtrate, ammonia was added as before and the amount used was noted. From these figures the required amount of filtrate of the sample digested at 100° C. may be calculated.‡ Twelve experiments as follows were made with samples of quinine from three manufacturers. Experiments I., II., and III. were made upon the same sample; experiments IV., V., and VI. on a sample from a different manufacturer; experiments VII., VIII., and IX. on one sample, and X., XI., and XII. on another sample from a third manufacturer.

No. of expt.	No. of c.c. of ammonia required for 5 c.c. of filtrate after digesting 1 grm. of the salt in 10 c.c. of water at 15° C	No. of c.c. of ammonia required for 5 c.c. of filtrate after digesting 1 grm. of the salt in 30 c.c. of water at 100° C.	Proportion
I.	7·1	8·8	8·8 : 7·1 :: 5 : x=4·03
II.	7·2	9·4	9·4 : 7·2 :: 5 : x=3·83
III.	6·6	7·9	7·9 : 9·6 :: 5 : x=4·19
IV.	8·9	8·5	8·5 : 8·9 :: 5 : x=5·23
V.	9·5	9·1	9·1 : 9·5 :: 5 : x=5·21
VI.	9·5	9·05	9·05 : 9·5 :: 5 : x=5·24
VII.	12·2	8·5	8·5 : 12·2 :: 5 : x=7·17
VIII.	10·9	7·9	7·9 : 10·9 :: 5 : x=6·89
IX.	11·3	8·2	8·2 : 11·3 :: 5 : x=6·90
X.	7·5	7·9	7·9 : 7·5 :: 5 : x=4·74
XI.	7·6	7·8	7·8 : 7·6 :: 5 : x=4·87
XII.	7·4	7·5	7·5 : 7·4 :: 5 : x=4·93

I found the average result of these twelve experiments to be 5·26 c.c. This figure may, however, be varied by further experiment, and in fact the amount varies for each sample. The variation depends upon the condition in which the cinchonidine sulphate exists. It may be deposited largely on the outside of the crystals of quinine sulphate, due to the incomplete separation of the mother liquor, in which case it may be easily dissolved; or it may be crystallised throughout with the quinine sulphate.

* 1877; *Pharm. Jour. and Trans.* [3], vii., 653.
† 1887; *Pharm. Jour. and Trans.* [3], xvii., 645.
‡ 1887; *Jour. de Pharm. et de Chimie.* [5] xxv., 5. *Pharm. Jour. and Trans.* [3], xvii., 585.
§ *Jour. de Pharm. et de Chimie.* [5], xxv., 115.
‖ 1880; *Archiv. der Pharm.* [3], xvii., 268. *Ber. Chem. Ges.*, Sept., 1880.
¶ 1887; *Archiv. der Pharm.* [3], xxv., 112. *Pharm. Jour. and Trans.* [3], xvii., 686.

* Or, what is equivalent, 5 c.c. of the filtrate may be taken, and 6·65 c.c. of water of ammonia added.
† If the temperature of the resulting solution was above or below 15° C. due allowance was made.
‡ The proportion is: The amount of ammonia used for the 5 c.c. filtrate from sample digested at 100°: amount of ammonia used for 5 c.c. filtrate from sample digested at 15° :: 5 : x.

(2) *The Effect of the Temperature of Titration upon the Amount of Ammonia Taken.*—In applying the U.S. Ph. test to a sample of quinine sulphate, I observed that portions of the same filtrate indicated that the salt should be included or excluded by the test according to the temperature of the liquid after filtration. On having the temperature of the room such that the resulting mixture should be very nearly at 15° C., a distinct turbidity was formed on adding seven c.c. of water of ammonia (sp. gr. 0·960) to five c.c. of the filtrate, while if the temperature of the titrated liquid rose to about 25° C., a clear solution followed. To determine the exact effect of the temperature during titration upon the amount of ammonia required, I proceeded as follows:—The standard quinine sulphate* was prepared from Böhringer's quinine sulphate by adding the calculated amount of sulphuric acid necessary to convert it into the bisulphate, which was dissolved in hot water nearly to saturation and cooled. The crystals were then drained and dried by means of bibulous paper and a press. They were dissolved a second time and dried in a similar manner. The quinine bisulphate was then converted into the normal sulphate by adding a solution of sodium hydrate to neutralisation.

The crystals were twice dissolved in hot water, cooled, dried between filter paper and a third time dissolved in hot water, cooled, and allowed to effloresce.† The solution was made by digesting the standard quinine sulphate in water at the ordinary temperature, then reducing it to 15° C. for two hours, and filtering at the same temperature.

* Various methods for the purification of quinine sulphate have been given. See Kerner, *Zeitsch. Anal. Chem.*, xx., 150; Prescott, *Pro. Am. Pharm. Assoc.*, 1878, p. 828; Davies, *Pharm. Jour. Trans.* [3], xvi., 358; Hesse, *Pharm. Jour. Trans.* [3], xvi., 818.

† In all my experiments where standard quinine sulphate was used it was prepared in the same manner.

The ammonia solution was standardised* by titrating it with a normal solution of oxalic acid, using the table of percentage and specific gravity given in the U.S. Ph., 1880.

Regulating the temperature of the room so that it was near the temperature at which I wished to titrate, I proceeded as follows:—10 c.c. of the standard quinine sulphate solution were measured into a small globe-shaped flask by means of a pipette, and ammonia water was added from a burette to within one c.c. of the quantity required to dissolve the precipitate first formed. The flask was then closed with a stopper and inverted once. More ammonia was added, a few drops at a time, and afterwards drop by drop. After each addition the flask was closed, inverted, and allowed to stand a few seconds, taking for the whole titration four to five minutes. Immediately after the precipitate was re-dissolved the temperature of the solution was taken. Bringing together all the titrations made at the same degree of temperature, about ten titrations having been made for each degree, I found the average titre of ammonia for each degree between 14° and 26° C. inclusive, as given in the table below. The extremes of temperature, 14° and 26°, were chosen, since they are about the limits of ordinary temperature. Finding the difference of titre between each degree and the one next above it, I took the average of these differences to represent in general the decrease of ammonia required for the increase of each degree of the

* In all cases where ammonia was used it was standardised by titrating with oxalic acid. For sp. gr. 0·920 ammonia percentage 21·8 was used; for sp. gr. 0·960 percentage 9·8 was employed. These data are from the table of Carius, U.S. Ph., p. 425. According to the observations of A. B. Lyons, *Proc. Mich. Pharm. Assoc.*, p. 189, the 21·8 per cent corresponds to sp. gr. 0·92119; and the 9·8 per cent corresponds to 0·96170 (water at 40° C.=1, and temp. obs. 150° C).

Temperatures	14°.	15°.	16°.	17°.	18°.	19°.	20°.	21°.	22°.	23°.	24°.	25°.	26°.
No. of c.c. of ammonia water sp. gr. 0·920 necessary for 10 c.c. of quinine solution	7·4	7·2	7·1	6·8	6·8	6·9	6·6	6·4	6·1	6·0	5·9	5·7	5·4
	7·4	7·1	7·1	6·8	7·1	6·7	6·7	6·3	6·1	6·0	5·7	5·5	5·6
	7·4	7·5	7·3	6·7	7·0	6·8	6·3	6·5	6·1	5·9	5·8	5·6	5·5
	7·3	7·2	7·3	7·2	6·8	6·7	6·3	6·3	6·2	6·0	5·9	5·7	5·5
	7·2	7·5	7·0	7·4	6·5	6·6	6·4	6·4	6·1	5·8	6·0	5·7	5·6
	7·3	7·3	7·1	7·0	6·7	6·4	6·2	6·4	6·1	5·8	6·0	5·8	5·6
	7·2	7·2	7·1	7·1	6·7	6·6	6·2	6·4	6·1	5·9	6·1	5·8	5·6
	7·4	7·0	6·9	7·0	7·0	6·4	6·4	6·4	6·1	5·9	5·8	5·8	5·4
	7·2	7·1	6·9	7·0	6·5	6·4	6·4	6·4	5·9	5·7	6·0	5·4	—
	—	7·3	—	6·6	6·7	6·5	—	6·3	6·2	5·8	5·6	—	—
	—	7·2	—	6·7	6·5	6·4	—	6·2	6·2	—	—	—	—
	—	—	—	6·8	—	6·4	—	6·1	6·1	—	—	—	—
	—	—	—	—	—	—	—	6·1	—	—	—	—	—
Average	7·31	7·23	7·08	6·92	6·67	6·56	6·38	6·32	6·10	5·88	5·88	5·66	5·54

General average of differences for one degree = 0·148 c.c.

Temperatures	14°.	15°.	16°.	17°.	18°.	19°.	20°.	21°.	22°.	23°.	24°.	25°.
No. of c.c. of ammonia water sp. gr. 0·960 necessary for 10 c.c. of quinine solution	10·5	10·6	10·5	10·2	10·1	9·9	9·9	9·6	9·5	9·0	9·1	9·2
	10·5	10·6	10·4	10·4	10·0	9·9	9·6	9·6	9·1	9·3	9·1	8·8
	10·7	10·3	10·3	10·2	10·2	9·6	9·6	9·6	9·1	9·2	8·8	8·6
	10·6	10·3	10·1	10·3	9·8	9·7	9·8	9·5	9·4	9·4	9·0	9·1
	10·6	10·2	10·5	10·1	10·1	9·8	9·7	9·6	9·5	9·2	8·9	8·9
	10·4	10·3	10·3	10·3	10·1	9·9	9·9	9·4	9·3	9·4	9·1	8·6
	10·5	10·4	10·1	10·3	10·2	9·7	9·5	9·6	9·3	9·0	9·0	8·7
	10·8	10·2	10·1	10·1	9·9	10·0	9·8	9·3	9·0	9·1	9·2	8·9
	10·5	10·6	10·4	10·3	10·0	10·2	9·5	9·6	8·8	9·2	8·7	8·8
	10·8	10·1	10·3	10·3	10·1	10·0	9·5	9·1	9·0	—	9·0	8·7
	10·4	—	—	—	9·8	9·5	—	9·3	9·2	—	9·0	—
	—	—	—	—	10·2	9·6	—	—	—	—	—	—
Average	10·63	10·36	10·3	10·25	10·04	9·90	9·78	9·52	9·31	9·15	8·99	8·83

General average of differences for one degree = 0·172 c.c.*

* It appears that of ammonia water of sp. gr. 0·960, there are required only 1·5 times more than of the water of sp. gr. 0·920, though the latter is 2·2 times stronger than the former.

centigrade thermometer. When ammonia water of sp. gr. 0·920 is used, the general average of all the differences is found to be 0·148 c.c., but for ammonia water sp. gr. 0·960 the general average is 0·172 c.c.

Then to obtain the correct amount of ammonia water, sp. gr. 0·920, necessary to re-dssolve the precipitate at 15° C., there must be added to the amount of ammonia used 0·148 c.c. for every degree of increase of temperature of titration. If ammonia water of sp. gr. 0·960 be used, then 0·172 c.c. must be added for every degree.

(To be continued).

THE FOUNDATIONS OF CHEMISTRY.*

By T. STERRY HUNT, LL.D., F.R.S.

(Continued from p. 195.)

8. The condensation which appears in the union of hydrogen and oxygen gases to form water vapour has been been defined as inter-penetration, but is more properly an identification of volume, or, to use Herbert Spencer's term, an integration of the two combining gases. When, however, a litre of hydrogen is mingled within a litre of chlorine gas at the standard temperature and pressure, the two unite with violence by the action of sunlight, of flame, or the electric spark, and form two litres of chlorhydric acid gas; the first action of light, according to recent observations of Pringsheim, producing a sudden and transient increase of volume (due perhaps to a disintegration of the chlorine, which marks a stage in the chemical process).† The properties of the combining gases are lost in those of the new compound, but, contrary to the general law of chemical union, in which intregration is attended by condensation, there is no loss of volume. We have in this case for the weight of a litre of the newly formed gas, not the sum of the weight of a litre of hydrogen and a litre of chlorine, but one half of that sum, or 18·25 times that of the litre of hydrogen.

Further light is shown upon this process by the history of the related fluorhydric acid gas, which at and near 100° has a density corresponding to HF. At about 19°, however, it is reduced to a liquid at the ordinary pressure, and between 20° and 30° yields, according to Mallet, a gas or vapour corresponding to H_2F_2, which by a slight elevation of temperature is readily transformed into 2HF. This gaseous compound of greater density is what in accordance with the general law of chemical integration should be formed by the union of H_2 with F_2, and we may conclude that in the case of chlorhydric acid a similar compound, H_2Cl_2, is possible, which, however, would at once pass, at the ordinary temperature and pressure, into 2HCl.

9. The capacity of the compound of fluorine and hydrogen to exist at the ordinary pressure in two gaseous states of unlike density serves to illustrate many similar facts in the history of elemental and compound species alike. Among the latter are the well-known examples of acetic aldehyde, acetylene, pentine, and the various polymers of these. Among the elements, oxygen when liberated in the decomposition of water by fluorine (Moissan), or by electrolysis, appears in part in the gaseous modification known as ozone, having a density one and a half times that of the ordinary form of oxygen—that is to say, its weight is not sixteen times but twenty-four times that of hydrogen at the same temperature and pressure. The effect of the electric spark, and of the silent electric discharge, to convert a considerable portion of dry oxygen into ozone, which is, however, rapidly resolved by heat, and more slowly at ordinary temperatures into common oxygen, $2O_3=3O_2$; the case of selenium, which yields a condensed vapour, Se_3, resolvable at a higher temperature into Se_2; and that of the triply condensed sulphur vapour, S_6, now found to be convertible at higher temperature into S_2, corresponding to the normal oxygen, O_2; the vapours of phosphorus and arsenic, represented by P_4 and As_4, partially changed by heat into P_2 and As_2; and finally, the vapours of bromine and iodine, Br_2 and I_2, which alike by heat and by the explosive and silent electric discharge are more or less completely changed into unstable vapours of Br_1 and I_1—are all illustrations, then unknown, of the same principle of greater or less gaseous condensation, first advanced from theoretical considerations by the present writer in 1848 (§§2, 3). The fact that the silent electric discharge at a low temperature effects a similar disintegration in the vapours of bromine and iodine to that wrought by great heat or by the electric spark, thus producing a change apparently the reverse of that produced by the same silent discharge in oxygen gas, leads to the suggestion that the generation of ozone thereby may be due to the momentary disintegration of a portion of oxygen, O_2, into 2O, which at low temperatures unites with an unchanged portion to form O_3.

The examples above given will suffice to show that the principle of chemical change by integration and disintegration appears not only in the relations of unlike species with each other, as of hydrogen with oxygen, with fluorine, with chlorine, or with sulphur and iodine vapours, but also with these same simple gaseous species among themselves. In other words, the more elemental gaseous forms of oxygen, of sulphur, of iodine, of fluorhydric acid, and of hydrocarbonaceous bodies, unite with themselves by homogeneous integration to form new gaseous species differing in specific gravity and in other physical characters, which have been designated allotropic or polymeric forms. Thus the same principle applies alike to the union of similar and dissimilar species, to homogeneous and heterogeneous integration, or, in the language long since adopted by the writer, to *chemical metamorphosis* as well as to *chemical metagenesis*.

10. We have seen that while the unit of weight is represented by the litre of hydrogen at 0° and 760 m.m., the unit of combination for the derived species, such as water vapour and chlorhydric acid gas, is represented by twice this volume, the species being, in the language of Hofmann, dilitral. The corresponding dilitral volume of hydrogen gas itself then becomes $H_2=2$, a fact which is indicated by applying to it the term diad or diatomic. To this type of condensation also belongs nitrogen gas, together with oxygen, chlorine, and the vapours of bromine and iodine in their ordinary conditions, that of sulphur above 800° and of selenium above 1200°, that of tellurium, and probably that of antimony. Oxygen in the form of ozone, and selenium at low temperature, are triad or triatomic, while the ordinary vapours of phosphorus and arsenic are tetrad, apparently becoming diad at higher temperatures, and that of sulphur below 550° is hexad. Iodine vapour, as we have seen, may be metamorphosed into a monad species, in which its weight is not 127 times that of hydrogen gas at the same temperature, but one-half that number; while the vapours of mercury and cadmium are known only in a monad form. A similar metamorphosis by expansion or homogeneous disintegration is, from analogy, possible for hydrogen at elevated temperature and reduced pressure; that is to say, the production of a monad form of hydrogen, H, corresponding to monad cadmium vapour, Cd, and monad iodine vapour, I, and having for a litre at 0° and 760 m.m. a weight of 0·0448 grm. Nor can we assign any reason *a priori* why the process of homogeneous disintegration may not go on still further, unless indeed it be limited by a process of heterogeneous disintegration which may resolve the

* Read before the National Academy of Sciences, April 17, 1888. Reprinted from the *American Chemical Journal*, vol. x., No. 5.

† Pringsheim, *L. E. D. Philos. Magazine*, Dec., 1887, from *Wiedemann's Annal.* for Nov., 1887. The writer had already suggested that "the power of flame, or the electric spa k, to effect the sudden union of chlorine and of oxygen with hydrogen, may be due to the effect of intense heat in separating momentarily into simpler forms portions of these gases, &c." ("A New Basis for Chemistry," § 57).

hydrogen into two or more unlike species, as supposed by Grünewald to be the case in the solar chromatosphere.

11. The weight of a litre of water vapour is made up of that of a litre of diad hydrogen, H_2, with that of half a litre of diad oxygen; while the weight of a litre of chlorhydric acid gas includes only that of half a litre each of diad hydrogen and diad chlorine, or of a litre of monad hydrogen integrated with a litre of monad chlorine. Reasoning from compounds like this, it has been assumed that the weight of monad hydrogen, 0·0448 grm. to the litre of standard temperature and pressure, is the smallest admissible, and that the weight of the element in a litre of any compound vapour or gas must be a multiple of this by some whole number; that of oxygen, if present, being in like manner not less than 7·98 times this same weight. The question arises whether we have as yet any experimental evidence of such homogeneous disintegration as should give in the litre of any vapour or gas at 0° and 760 m.m. quantities of hydrogen or of oxygen not in accordance with these weights. In the vapour of ordinary water, in which the ratio by volume of H : O = 100 : 50, it is evident that there is no deviation from these values; but if, admitting the existence of an oxygenised water as described by Schützenberger, in which that ratio is 100 : 51 (1·0 : 8·14 by weight), we suppose this to be converted into a homogeneous vapour containing in a litre 0·0896 grm. of hydrogen, it is evident that the oxygen, being not 0·0896 × 7·98 but 0·0896 × 8·14, will be equal to one and one-fiftieth portions. Further evidence of the distinctness of such oxygenised water, and of a similar oxygenised carbon dioxide described by Schützenberger, is however to be desired before the existence of such dissociation can be established.

12. We have now considered two kinds of chemical union:—(1) heterogeneous integration, or the identification of volumes of unlike species, and (2) homogeneous integration, or the identification of volumes of like species, in which consists the so-called polymerisation and most cases of allotropism. Both of these modes of union have a wide range, dependent on pressure; and the gaseous species formed by the first process become, like the elements themselves, the subjects of the second process. The process of integration by successive steps gives rise to homologous or progressive series, as in the paraffines, the olefines, the acetylenes, the benzenes, and other hydrocarbonaceous series, in recognised species of some of which the coefficient of the carbon is not less than 30. In the olefines, $n(CH_2)$, the first term being the same as the common difference, all the succeeding members of the homologous series are polymers thereof, constituting what we have called *isomeric homologues*. This name serves to distinguish them alike from those homologous series in which the first term is unlike the common difference, and which are *anisomeric homologues*, and from these isomeric compounds which are formed by successive homogeneous integrations, and between which, as between the allotropic forms of the elements, there is no apparent homology or similarity of function.

Familar examples of such allotropic derivatives of species, themselves formed by heterogeneous integration, are seen in the successive condensations or homogeneous integrations of pentine, of acetylene, of cinnamene, and of the aldehydes, some of which take place spontaneously or with very slight provocation not only in gaseous but in liquid species. Besides the olefines among the hydrocarbons, we find in bodies like the carbon-spars $n(CMO_3)$, examples of what must be regarded as isomeric homologues, and perhaps, though less apparently so, in the different allotropic forms of the titanium and silicon dioxides, wherein that similarity of function which marks homology is either non-apparent, from their chemical indifference, or else is absent. The latter is evidently the case in many cases of compounds the empirical formulæ of which present good examples of progressive series, as in the metallic oxides, sulphides, and arsenides. An illustration of this is afforded in the observed compounds of manganese with oxygen, among which are MnO, Mn_3O_4, Mn_2O_3, Mn_5O_8, MnO_2, MnO_3, Mn_2O_7, and MnO_4, which, however, with but two exceptions, are known to us not in gaseous species, but only in highly condensed forms.

13. As the higher hydrocarbons of the various progressive series are built up by the integration of successive units of CH_2 with the first term of each series, so the monovalent alcohols and the corresponding ammonias are generated in a similar manner from H_2O and NH_3. The capacity of such integration, or, in other words, the fixing power of such an integer as H_2, HCl, or NH_3, is very great, and theoretically knows no limit. By this consideration our conception of so-called atomicity or valency, which for an element has been defined as "its atom-fixing power measured by atoms of hydrogen" (J. P. Cooke), is greatly enlarged. Thus measured, chlorine is made monovalent, carbon tetravalent, and sulphur, like oxygen, divalent, although from its union with O_3 its hexavalence has been affirmed, a view which is sustained by the hexiodide of sulphur of Landolt, SI_6, and by the crystallised artificial sulphide of iron and nickel of Mackintosh (SFe_4Ni_2), while from the described iron sulphide, SFe_8, its octovalency would follow. Indeed, as there is reason to believe that the compounds of metallic iron formed in the blast-furnace with much smaller proportions of sulphur are homogeneous, it may be maintained that there is no limit to the valency of sulphur save that determined by the integral weight of the element on the one hand and that of the very highly condensed species known to us as molten iron on the other. Similar conclusions follow from the solution of carbon in the same metal, forming therewith compounds in which the hardness, fusibility, and magnetic relations of the metal are modified in a notable manner. The characteristic properties of the apparently homogeneous compounds of small proportions of both silicon and phosphorus, alike with iron, with copper, and with other metals, and those of various metallic alloys, will at once suggest themselves to the chemist. In this connection may also be mentioned for illustration the solution of oxygen in molten copper, and that of the same gas in melted silver, forming a compound stable at high temperatures, but disintegrated on cooling at the ordinary pressure.

14. The power of fixing hydrogen possessed by various metals is not less instructive. The amount retained by palladium corresponds to Pd_2H, while potassium and sodium form therewith compounds of a certain stability, represented respectively by K_2H and Na_2H.* The capacity of the latter compounds to unite with smaller additional quantities of hydrogen, and that of other metals to combine with small amounts of the same elements, show that the limit to be assigned to this power of fixing hydrogen by various metals presents as wide a range as that observed by the metals for sulphur, phosphorus, silicon, or carbon. The fixation of bodies in chemical union or solution is not the prerogative of one element rather than another, as the popular statement of the doctrine of valency would seem to imply. The question of the stability of a chemical compound, whether formed by homogeneous or by heterogeneous integration, is one of temperature and pressure; and heat, which readily effects the disintegration of the hydrides just mentioned, decomposes either wholly or partially, at the atmospheric pressure, many metallic oxides. That the amount of one body retained in union with another is thus dependent on temperature, the pressure being constant, is well illustrated by the experiments of Spring on the arsenides of cadmium. The native metallic arsenides have for 100As quantivalent ratios for the metals represented by 33·3, 60, 66·6, 100, 150, 300, and 500, the latter = 1 : 5 being generally regarded as representing the maximum fixing power or atomicity of arsenic, hence designated as pentavalent. When, however, cadmium is fused with an excess

* Troost and Hautefeuille, *Comptes Rendus*, lxxviii., 968.

of arsenic at a low red heat, a large part of this is volatilised, and there remains a very hard metallic body giving essentially the ratio 1 : 6. It was not found possible to get by way of fusion a compound retaining a larger amount of arsenic, and this for the evident reason assigned by Spring, that "at the elevated temperature at which the combination of cadmium and arsenic takes place under ordinary pressure, the tension of dissociation is such that an arsenide is produced containing but little arsenic."* At ordinary temperatures, on the contrary, or under strong pressure, we have not to reckon with this tension of dissociation, and we readily get combinations containing a larger proportion of the volatile element. It is not the metal-fixing power of the arsenic, the oxygen, the sulphur, or the hydrogen, but rather the power of the metal to fix these more volatile elements under various conditions of temperature and pressure which we have to consider.

15. The ideal gas responds perfectly to external pressure, obeying implicitly Boyle's law; the ideal solid is, on the other hand, theoretically incompressible. Gas and solid are, however, alike expansible by heat, and this dynamic change of volume by thermic expansion, which is regular and constant, is thereby distinguished from changes of volume from chemical metamorphosis, which are periodic. Thus, at the standard pressure, water below 0° is a solid, while from 0° to 100° it is liquid, and above this point a vapour, which, so far as observed, has, like the liquid, its own nearly constant rate of thermic expansion. The vapour of sulphur, however, which from 450° to 550° has a density ninety-six times that of hydrogen, assumes above 800° a density only thirty-two times that of hydrogen. In the case of iodine-vapour, and of the vapours of fluorhydric acid, of nitric peroxide, of acetic acid, of acetic aldehyd, of many hydrocarbons, and of solids which like arsenic, phosphorus, and tin undergo allotropic transformations, we see examples of the same periodic chemical changes.

16. The question of greater or less density of gas or vapour for elements, and for so-called polymeric species, as compared with that of the hydrogen unit, is a question of greater or less homogeneous integration. Moreover, the gaseous, liquid, or solid condition is theoretically wholly dependent on temperature and pressure, as pointed out in § 6. It is known that liquid species, if not subject to heterogeneous disintegration by heat, pass thereby, under increased pressure, into vaporous forms far denser than the normal vapours, which, while having the character of condensed or polymeric species, are stable only within certain narrow limits, and alike by increase of temperature and by diminution of pressure are changed, through homogeneous disintegration, into less condensed vaporous species. The genesis and the transformations of these heavy vapours thus imply a chemical process analogous to that observed in the denser and lighter vapours of sulphur, iodine, fluorhydric acid, nitric peroxide, acetic aldehyd, and acetic acid.

W. Allen Miller long since pointed out that the dense vapours of ether and alcohol formed just above the critical points of these liquid species have tensions far less than belong to the normal vapours, and, moreover, that the abnormally dense vapours of these liquids on augmentation of temperature not only present a much greater rate of expansion than air or water vapour, but, instead of being like these, constant therein, show a rapidly increasing coefficient of dilatation.† These phenomena, as we have elsewhere remarked,‡ are in accord with those presented by sulphur, which, near its point of condensation, yields a dense hexad vapour readily disintegrated at a higher temperature (and doubtless also by reduced pressure) into a less dense diad vapour. Applying, then, Boyle's law to the tension of ether vapour as observed just above its critical point, we find it to be not the normal vapour, but a highly condensed polymer, which, by increase of temperature, is metamorphosed into less and less condensed species, as shown by the very rapid increase of the elastic force as compared with that of air under similar conditions of temperature and pressure.

In illustration of this point we may note that Ramsay and Young have lately observed that the vapour of alcohol at 243° has a tension of only 63 atmospheres and a specific gravity of not less than 0·280, water being 1·000. This corresponds to a fourfold condensation, $4(C_2H_6O)$, since the normal vapour of alcohol calculated for that temperature and pressure should, according to Boyle's law, have a specific gravity of 0·0684, or but one-fourth of the number observed.

(To be continued).

* Formation de quelques arséniures métalliques par l'action de la pression. 1883. *Proc. Roy. Acad. Belgique*, (3), v., No. 2.
† Miller, "Chemical Physics," 3rd edition (1863.)
‡ "A New Basis for Chemistry," 2nd edition, § 117.

CORRESPONDENCE.

ANALYSIS OF FERTILISERS.

To the Editor of the Chemical News.

Sir,—Mr. Buchan (Chemical News, vol. lviii., p. 195) raises the question of a possible source of error existing in the results of my experiments on the determination of P_2O_5 (Chemical News, vol. lviii., p. 170); I therefore desire to state that when conducting these experiments, with a view to ascertaining the effect produced on the determination of the P_2O_5 when it is omitted to bring the acid solution of phosphate to complete dryness, prior to its precipitation, I did not overlook the possible formation of pyrophosphate below a temperature of 150°, but took care to avoid, and otherwise prove, the absence of such source of error before asking you to publish them.

Mr. Buchan suggests that my letter leads to the conclusion that, in the majority of cases, the determinations of P_2O_5 by the magnesia method are too high, also that it presses very sorely and unfairly against manure manufacturers: to this I have to say, as regards the former conclusion, that if, in the majority of cases, the evaporation of the acid solution of the phosphate to complete dryness be neglected, then in the majority of cases the results obtained are too high; such is my experience. As to the latter conclusion, my letter was not written with any intention of doing injustice to manufacturers, though I take no cognizance of trade interests in the matter, for it is purely a question of principle, of chemical accuracy; and I think Mr. Buchan will be disposed to admit that if the whole of the silica be rendered insoluble in analysing the raw materials purchased, and the same mode of procedure applied in the analyses of the manufactured goods vended, neither his firm nor the purchasers of their fertilisers will suffer any injustice.—I am, &c.,

Alfred Firby.

98, Albion Street, Leeds,
October 23, 1888.

ARSENIC IN THE HOME.

To the Editor of the Chemical News.

Sir,—The article by Mr. A. W. Stokes under the above heading, which appeared in the Chemical News (vol. lviii., p. 189), is very interesting, in so far that it shows that the use of poisonous pigments is being again revived in a perfectly needless way.

In 1860 or 1861 Prof. A. W. Hofmann drew attention to the fact that arsenical pigments were largely used in colouring the green fabrics, at that time used very extensively for ball dresses. So serious was the scare produced that I frequently had to examine twenty-five materials per week for arsenic. Schweinfurth green was the pigment usually met with. Green wall-papers had fallen into bad repute, in sympathy with these green-coloured fabrics.

Now when we consider how these pigments were applied to the "tarletans" used for ball dresses, we can hardly be surprised at the result likely to follow. Ultimately these pigments gave way to a green dye, produced by superposing a yellow on an indigo-dyed fabric.

In testing these fabrics with Marsh's apparatus a serious trouble was met with in the frothing which invariably took place. Reinsch's test was on this account prepared, ordinary fine copper wire, as used for electrical purposes, being used.

Many people who sit for any length of time in a room papered with a green coloured paper complain of headache. Some years ago a friend of mine gave me some dust swept off a bookcase which belonged to his studio, which was covered with a green flock paper. There was no difficulty in finding arsenic in the dust, which was ultimately referred to the paper.

Some green pigments which are not arsenical are impregnated with arsenic, from its being an accidental impurity, and here, I am afraid, would be found some difficulty in the way of legislation.

I met with a sample of copper wire which had an electrical conductivity of only 30 per cent that of pure copper wire. Arsenic was suspected of being present; the wire was found to contain about 5 per cent metallic arsenic. We have only to imagine Brunswick green being derived from the same source as this wire to realise the difficulty. Zinc and antimony often contain more than copper.

What is to be the fate of fireworks containing arsenic or mercury? Many enamels are rich in arsenic.

The use of poisonous materials cannot be too highly censured, however, employed for such purposes as mentioned by Mr. Stokes. Publicity is the safest check against the unnecessary employment of dangerous chemicals or processes. A tradesman or manufacturer pays more regard to an outburst of popular indignation than he does to an Act of Parliament.—I am, &c.,

THOMAS T. P. BRUCE WARREN.

Tamworth Villa, Earlham Grove,
Forest Gate, E.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 14, October 1, 1888.

This issue contains no chemical memoirs.

Zeitschrift fur Analytische Chemie.
Vol. xxvii., Part 4.

A Spirit Furnace.—Paul Schoop.—A memoir of little interest.

A Gas Burner.—F. P. Venable.

A New Form of Liebig's Condenser.—E. Hart.

On Burettes and Pipettes.—W. O. Attwater and C. B. Woods.

A Burette for Titration with Solution of Permanganate.—Clemens Jones.—These four papers are from the *Journal of Analytical Chemistry*.

Bottle for Filling Burettes.—A. Stein (*Chemiker Zeitung*).—This device is shown in a figure, but does not admit of intelligible description.

An Absorption Apparatus for Burettes with Overflow Points.—A. Beutell (*Chemiker Zeitung*).—An arrangement to prevent the absorption of carbonic acid in the use of caustic alkalies, and especially baryta-water.

A Bottle Burette.—F. H. Morgan.—From the *Journal of Analytical Chemistry*.

Drying Apparatus.—K. Ulsch.—This apparatus consists of a glass tube provided below with a narrow aperture for receiving the material to be dried, which must not occupy more than half the space. This glass tube is fixed in a copper tube, somewhat wider, closed below and provided above with a lateral tube, so that the air-space thus formed is tightly closed above. The glass tube is placed in connection with an aspirator, whilst the side-piece of the copper tube allows dried air to enter. R. Rempel describes (*Chemiker Zeitung*) a similar apparatus, consisting of two concentric cylinders.

Air-bath with a Constant Temperature in Different Parts of the Internal Drying Chamber.—Hermann Rohrbeck (*Chemiker Zeitung*).—This apparatus cannot be intelligibly described without a figure.

Vacuum Drying Apparatus.—P. Schoop (*Zeitschrift für Chemische Industrie*).—The same remark applies to this paper.

Water-Sprengels.—O. N. Witt (*Chemiker Zeitung*).—This apparatus is constructed on the principle already proposed by Mendeleeff, Kirpitscheff and Schmidt, Jagno, and Linnemann. It is represented in the two accompanying figures.

A Water-Sprengel.—R. Law.—From the CHEMICAL NEWS.

The Action of Water-Sprengels.—E. Pflüger (*Chemiker Zeitung*).—The author mentions that when the pressure in the recipient is reduced to a minimum the air is almost absolutely removed, and the slight remaining pressure is due to watery vapour. If monohydrated sulphuric acid is allowed to enter the recipient after it has been cut off from the pump, the watery vapour is absorbed. In consequence a further reduction of temperature takes place, so that an almost perfect vacuum is obtained. But if the acid is introduced beforehand into the recipient it causes, after a certain point of exhaustion is reached, a current of watery vapour to flow into the recipient, and prevents the remaining air from escaping. The vacuum obtained in this manner is less perfect than one produced without the use of sulphuric acid.

A Circular Mercurial Pump.—K. Antolik.—The apparatus is not described.

Arrangements for Rapid Filtration.—Clemens Jones.—From the *Journal of Analytical Chemistry*.

The Filtration of Tedious Liquids.—A. B. Clemence.—From the *Journal of Analytical Chemistry*.

A Modification of Soxhlet's Extraction-apparatus.—J. J. Barlow.—From the CHEMICAL NEWS.

Apparatus from Fractionated Distillation.—U. Gayon.

Two Arrangements for Collecting Gas out of Liquids contained in Corked Bottles.—C. Reinhardt.—These two memoirs are not adapted for useful reproduction.

Apparatus for Generating Pure Oxygen in Quantity.—Br. Tacke.—The author describes in *Chemiker Zeitung* an improved form of his original appartus. Instead of the iron tube he uses one of brass, the bottom of which is joined on with hard solder.

The Production of Sulphurous Acid in Quantity.—H. N. Warren.—From the CHEMICAL NEWS.

An Excellent Reduction Agent for Analysis in the Dry Way.—F. Nelissen.—The author recommends sodium formiate, which he prepares by neutralising crude formic acid (as obtained in the well-known manner by distilling glycerin and oxalic acid) with soda-lye free from sodium sulphate, evaporating the solution to dryness, and desiccating at 130°. The action of sodium formiate depends on the circumstance that at elevated temperatures it is resolved into sodium carbonate with liberation

of hydrogen and carbon monoxide. The reductive action of these gases in the nascent state is so powerful that lead, copper, bismuth, antimony, and silver are obtained at once in metallic globules, even in the oxidation flame.

Separation of Nickel and Cobalt from Iron.—J. B. Mackintosh. — The author revives the old method, depending on the different behaviour of the sulphides with dilute hydrochloric acid. He throws down the metals from a boiling solution with ammonium sulphide, and treats with dilute hydrochloric acid. In this manner is obtained a residue containing nearly all the nickel and cobalt with mere traces of iron and a solution containing almost all the iron, with but small quantities of nickel and cobalt. The iron is separated in the well-known manner as a basic salt both from the residue and the solution, an operation which is easier and more expeditious than the separation of the three metals by direct basic precipitation.

The Action of Sulphuretted Hydrogen upon Arsenic Acid. — B. Brauner and F. Tomicek.— The authors confirm the statement of R. Bunsen that on precipitating an acid solution of an arseniate according to his directions arsen-pentasulphide is obtained.

A Reaction for Aldehyds.—Michael and Ryder.—From the *American Chemical Journal.*

Detection of Aldehyd. — W. Windisch (*Chemiker Zeitung*). — The author uses metaphenylene - diamine hydrochlorate. If a freshly prepared aqueous solution of this salt is added to an aqueous or alcoholic solution of aldehyd there appears a yellow zone, which disappears on the addition of the fixed alkalies or ammonia, and is restored on the addition of hydrochloric acid.

The Detection of Acetic Acid in Presence of Morphine. — G. Stillingfleet Johnson. — From the Chemical News.

Determination of Nitrogen in Organic Matters.—"The Association of Official Agricultural Chemists."—From the Chemical News.

Determination of Alkaloids with Meyer's Reagent (Potassium Mercury Iodide).—A. B. Lyons.—From the *American Journal of Pharmacy.*

Methods for Determining the Amides in Vegetable Extracts.—E. Schulze.

Determination of the Nitrogen of Ammonia of the Amide-amidic and Amine-amidic Compounds in Natural Products.— Antonio Longi.— These memoirs are merely mentioned without being abstracted.

Determination of Glycerin.—L. Legler.—The author proposes to oxidise crude glycerin with potassium dichromate and sulphuric acid, and to deduce the quantity of glycerin from that of the carbon dioxide formed. Methods have also been proposed by Messrs. Cross and Bevan (Chemical News), O. Hehner (*Analyst*), E. Baumann, R. Diez, A. H. Allen (*Analyst*), and Jolles.

The Volatility of Glycerin along with Watery Vapour.—Otto Hehner.—From the *Analyst.*

The Examination of Fats.—This memoir will be inserted at length at the earliest opportunity.

The Use of Congo Red as Indicator in Ascertaining the Reaction of Urine.—E. Brücke.—Ammoniacal salts decidedly interfere with the examination by means of congo-red. Acid salts, such as acid ammonium or potassium tartrate, affect congo-red in the same manner as urine.

Determination of Nitrogen in Urine.—W. Camerer.—Not adapted for abstraction.

A Modification of the Soda Test for Carbon Monoxide Hæmoglobine.— E. Salkowski.—The blood is mixed with twenty parts of distilled water, and a portion is mixed in a test-glass with an equal volume of 1·34 sp. gr. Carbon monoxide blood becomes dullish white, then a bright light red, and on standing separates into light-red flakes which collect on the surface, and a faint rose-coloured liquid. Normal blood, if similarly treated, turns a dirty brown colour.

Detection of Sulphuretted Hydrogen in Urine.—F. Boneko.—The author uses the methylene blue reaction. The sample is mixed with five drops of hydrochloric acid, one to two drops solution of ferric chloride, and a few grains of paramido-dimethylaniline hydrochlorate.

Approximate Quantitative Determination of Peptone.—E. Salkowski.—The author employs the xantho-protein reaction.

Ferments in Normal Urine.—Like Leo and H. Hoffmann, E. Stadelmann was able to detect a peptic but not a tryptic ferment in normal urine.

The Examination of Gastric Juice.—This memoir does not admit of useful abstraction.

The Toxicological Detection of Bromine and Iodine.—Vitali.—If 1 grm. bromine or iodine is dissolved or suspended in water and brought in contact with at least 300 grms. finely minced flesh, every smell of the halogens disappears in a few minutes, and no trace of them is to be found in a free condition, as they are principally converted into halogen hydracids, which exist partly in the free state and partly in combination with albumenoids. These compounds are soluble partly in alcohol but partly only in water. The halogens can be obtained from the residue of the extracts by treatment with caustic alkali.

Chemico-legal Detection of Blood-stains.—Ferry de la Bellone (*Chemiker Zeitung*). — Tissues upon which blood is suspected are reduced to fibres and let float on the surface of a dilute solution of sodium chloride (1 : 1000). If blood is present the liquid takes a brownish rose colour, which may be more closely examined by means of the spectroscope. If hæmoglobine is recognised a drop or two drops of solution of chloral are added to the contents of the test-tube. There is formed a rose-coloured precipitate, from which, after settling, the supernatant liquid is removed with a pipette. A drop of the residual matter is laid upon a glass slip, which is then moved up and down over a small alcohol flame. The pale liquid is removed from the reddish coagulum by means of slips of filter-paper. The clot is then stained with magenta, the excess of colour removed with water, a drop of acetic acid is added, and the glass cover is put on. Under the microscope the dyed globules are recognised by their characteristic form. If the suspicious spot is found upon instruments, wood, or paper, they are scraped, and the scrapings are suspended in a little bag in the sodium chloride. If soil is soaked with blood the particles which are thus coated are selected out under a low magnifying power and treated as above.

Re-determination of the Atomic Weight of Thorium. — Gerhard Krüss and L. F. Nilson. — The vapour-density of thorium chloride confirmed the quadrivalency of thorium.

Revue Universelle des Mines et de la Metallurgie.
Vol. ii., No. 3, June, 1888.

Determination of Sulphur in Commercial Irons and in Sulphides Decomposable by Acids.—Dr. L. L. de Koninck.—In 1870 the author published a process for the determination of the sulphuretted hydrogen given off by sulphuretted irons on treating them with hydrochloric acid or dilute sulphuric acid. This process consists in condensing the sulphuretted hydrogen in a series of three small washing-bottles containing a neutral solution of silver nitrate at two per cent; in collecting the precipitate of silver sulphide and determining the sulphur. This determination is effected by treating the precipitate with bromine in presence of water, filtering off the silver bromide, and precipitating the sulphuric acid formed with barium chloride. The barium sulphate formed is very pure, being produced in a liquid free from fixed matters.

Latterly the author has sought to simplify the process by substituting mercury for silver; the mercury forming, with bromine in excess, a soluble and volatile product, the advantages of the original process would be retained, and the filtration and washing of the precipitate of silver bromide would be avoided. To this end he absorbs the sulphuretted hydrogen in a mixed solution of mercury cyanide and ammonium chloride. This mixture readily absorbs the sulphuretted hydrogen, giving a black flocculent precipitate which is easily collected on a filter and washed. On treatment with bromine and water it dissolves rapidly and completely, especially at a slightly elevated temperature, yielding sulphuric acid and mercury bromide. This process has been carefully verified and found strictly accurate.

Determination of Manganese in Steels.—Franck Julian.—One grm. of metal is dissolved in 15 c.c. of nitric acid (sp. gr. 1·2), evaporated down to 5 c.c., 20 c.c. of strong acid are added, and the liquid is precipitated in heat by potassium chlorate, avoiding a large excess. There are then added successively to the mixture 5 c.c. of strong nitric acid, 60 c.c. hot water, and 10 c.c. of the oxalic solution. The liquid is agitated until it takes a light yellow colour, and the excess of oxalic acid is titrated by means of permanganate, operating at a temperature of about 70°. The manganese dioxide dissolves rapidly under the influence of oxalic acid; the back titration is done quickly, and the end of the reaction is easily found after a little experience. The solutions employed are:—Ammonium oxalate at 15 grms. per litre. Potassium permanganate at 1·6 per litre. To determine the standard of the permanganate we take 10 c.c. of the solution of oxalate, add 50 c.c. of hot water, and the nitric solution of 1 grm. of steel, from which the manganese has been eliminated by precipitation with potassium chlorate and separating the precipitate with an asbestos filter.

Vol. iii., No. 1, July, 1888.

The only chemical matter in this number is a translation of the Presidential Address delivered by Mr. Crookes before the Chemical Section of the British Association at the Birmingham Meeting, 1886.

No. 2, August, 1888.

Arrangement for Titration in Heat.—Prof. L. L. de Koninck.—The apparatus devised for this purpose cannot be described intelligibly without the accompanying figure.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Oil Casks.—Are there any means of preventing the absorption of pure olive oil into the wood of the casks in which it is imported into this country not affecting the absolute purity of the oil? What is a fair percentage of absorption in new casks of well seasoned wood?—Oil.

MEETINGS FOR THE WEEK.

Thursday, Nov. 1st.—Chemical, 8. "The Constitution of the Terpenes and of Benzene," by Dr. W. A. Tilden, F.R.S.

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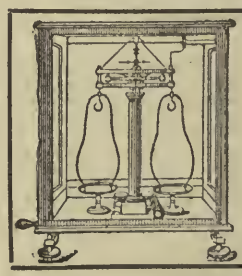

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1510.

THE AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Before proceeding to the agreeable task of noticing the admirable Inaugural Address of the President, Mr. C. H. Russell, we must bestow a glance at the constitution of the Association. This body, though founded upon the lines of the parent Association in the Home Kingdoms, differs from it in several respects. It has retained that objectionable feature, the Section for "Economic Science and Statistics." We say objectionable, because statistics must be regarded, not as an independent science, but as a method, applicable in various science. As for "Economic Science," experience has proved that the deliberations of such a Section border too closely upon politics to be either safe or desirable. We cannot help, also, looking with a certain jealousy upon the creation of a Section for "Literature." It has been too often found, in the so-called "Literary and Philosophical Societies" of Britain that literature monopolises too much of the attention and resources of the Society, and regards science with something more than mere passive dislike.

Mr. Russell, in his impressive and brilliant address, after noticing the part played by the British Association, especially in its earlier days, argued with great justice that in so vast and thinly-peopled a continent as Australia an analogous body to bring to a focus the scientific ability and the research scattered throughout the colonies was even more needful. He was then compelled to combat the old enemy, utilitarianism. He quoted a "well-known politician in another colony who, when asked to spend a few pounds on pure science, replied :—' Will it affect the price of beef and mutton ? If not I won't spend a shilling on it.' This old delusion, which still haunts the British Empire though our most formidable rivals have got rid of it, was ably exposed by Mr. Russell.

The President did not feel himself compelled to a direct encounter with the Ethical School of Utilitarians, who, on hearing of researches, astronomical, chemical, or biological, sneeringly ask if we could not be "good and happy" if nebulæ and rare earths and microbia had never existed ? But he could not help referring, though briefly and very courteously, to the jealousy with which the progress of Science is regarded by the students of the so-called "humanities." He said :—"There have been those who said that the proper study of mankind is man, and who, while strenuously denying to this study the dignity of a science, have thought no other science worthy of culture. And there have been others who have asserted that man's only study was nature in the things around him, neglecting altogether the science of man." To these two views Mr. Russell replies :—"But man and nature are correlative, and therefore true; science must embrace both studies." This, we submit, is scarcely a satisfactory answer. Man is part and parcel of nature, though its most complex and highly differentiated part, and in that light alone can he be successfully studied.

The jealousy of the progress of science felt by the literary world found its expression from the mouth of no less important a person than Sir William Manning, Chancellor of the University of Sydney. This gentleman contrasted Science with a something which he called "general education." He expressed a hope "on behalf of the University that the attractions of Science will not take the youth of this colony too much away from general education. There is no doubt Science has great attractions which may lead many not to study the writings of antiquity." This view, which was again and again put forward during Sir W. Manning's speech, is profoundly to be regretted if we are to take it as the voice of the University of Sydney.

Some of the New South Wales papers comment upon what they call the "unevenness" of the programme of the Association. The sections in which the number of papers to be read is large were those of chemistry and mineralogy, geology and palæontology, biology, anthropology, and architecture and engineering. The section devoted to astronomy, mathematics, physics, and mechanics is moderately well occupied, but in the sections for geography, economics and statistics, sanitary science, and literature and the fine arts the entries number only three each.

Now this "unevenness" is precisely what must follow if Australian men of science obey the good old rule of doing the work that lies close at hand. In chemistry, geology, and biology, with their allied branches, there are evidently a vast number of questions which can be successfully taken in hand only in Australia. On the other hand, a residence in the Colonies offers no special facilities for the study of mathematical, physical, mechanical, economic, or literary subjects, and these latter, therefore, were wisely left in comparative abeyance.

The newspapers, however, have unfortunately taken a different view of the matter, and have reported the economic papers at great length, whilst the proceedings in the chemical and geological sections have received but scanty notice.

THE VALUATION OF OIL-CAKE.

By THOMAS T. P. BRUCE WARREN.

Cotton-cake is preferred to linseed-cake as cattle food, but it is easy to understand that several kinds of cake may be mixed together. A short time ago Mr. Voelcker pointed out, in the Chemical News, the use of the microscope for detecting this.

In the Chemical News (vol. lviii., p. 196) is an extract on "Determination of Fatty Matter in Linseed-Cake." The author points out that in drying the cake there is a diminished yield of oil.

Now this is quite easy to understand ; the residual oil contained in a cake is very liable to oxidation, and a thoroughly oxidised oil is practically insoluble in any solvent. Crushed poppy-seed is remarkable in this respect ; and, as a rule, the insolubility of the residual oil is just in proportion to its tendency to oxidise : heat invariably facilitates this. In drying an oil-cake the same precaution should be taken as in drying an oil or fat, but which unfortunately seems neglected.

It is better to remove the oil by solvents first, especially if a well-defined drying oil is present, and to allow the water to subside in a warm place, in a well-closed vessel, so as to avoid oxidation. By passing a current of ozonised oxygen into the oil it is quite easy to form some idea of what we are dealing with ; by noting the difference in the iodine absorption, an oil easily oxidised—as poppy, linseed, and hempseed—is detected from rape and cotton. If the extracted oils are "blown," with heat applied at the same time, the two latter oils can be detected by the colour of the coagulum produced by sulphur chloride. Cotton oil yields a much lighter product than the other oils : the dark colour results principally from the liberation or expulsion of glycerin ; the free fatty acids yield dark, and in some cases black, products.

It is not an uncommon thing to find oil-cakes containing rosin oil, the inference being that the marc is nearly exhausted, and then the oily matter made up with oils from other sources.

The same oils oxidised cannot be considered equal as heat producers.

The electrical resistance of an oil extracted from a

pure cotton-cake is enormously higher than the oil yielded by any other oil-cake; then follow, in order, rape, poppy, and linseed.

When the powdered seeds are steamed previous to crushing it ought not to be forgotten that we are bringing about a condition favourable to oxidation, but the same thing will happen by simple exposure. The crushed linseed sold by druggists for medical purposes rapidly changes, by the oxidation of the oil, if exposed in an open vessel.

THE FOUNDATIONS OF CHEMISTRY.*

By T. STERRY HUNT, LL.D., F.R.S.

(Concluded from p. 206).

17. The progressive stages which in sulphur, iodine, fluorhydric acid, and acetic acid are marked in the process of homogeneous disintegration by heat at the ordinary pressure, do not, however, occur in the cases of ether, alcohol, water, and similar volatile liquids, except when these are heated under increased pressure; conditions under which all liquids not thereby exposed to heterogeneous disintegration may theoretically assume the gaseous state. The intermediate forms in the metamorphosis of volatile species are of very different degrees of stability, and while in many cases capable of existing at the ordinary pressure through a certain range of temperature, in others exist only within such narrow limits of temperature and pressure that we are led to conjecture from analogy that within still narrower limits there may exist many other intermediate species hitherto unknown and unsuspected. It may even be supposed that every variation in pressure acting upon compressible species gives rise to some passing chemical change too fugitive to be detected. It is known that variations in pressure control the production of allotropic forms in the case of solids, and may we not from analogy expect the same principle to apply in the action of pressure upon all bodies which depart from the theoretical elasticity of the perfect gas? The ideal gas responds perfectly to every variation of pressure, according to Boyle's law, while the ideal solid is on the contrary incompressible (§ 15), but the representatives of both of these can exist only within certain limits of temperature and pressure.

18. The seeming continuity of the liquid and the gaseous states of matter, as seen in the dense vapours discovered by Cagnaird de Latour, and the fact that gaseous matter by successive condensations under great pressure assumes at high temperatures a condition not of liquidity, but of dense gas or vapour, as set forth by Andrews, receives a remarkable illustration in the discoveries of Hannay and Hogarth.† These chemists have found not only that solutions of salts in alcohol and ether have their critical points, above which they pass integrally into the state of dense vapours, but that the dense vapours of the solvent liquids themselves have, like condensed hydrogen gas, the power to take into solution various solids. The fact that water (and probably watery solutions also) will pass into the state of dense vapour not far from 400° (as long since shown by Cagnaird de Latour), and that this vapour is, moreover, as found by the authors just cited, a solvent alike for silica, alumina, and zinc oxide, is one which throws great light on many problems in geogony and physiological mineralogy. It leads us to conclude that liquid water does not exist in highly heated rocks at considerable depths from the earth's surface, where, however, it may be present either in chemical combination, reducing their fusing point, as shown in the late researches of Tilden and Shenstone, or liberated, and pervading them as a dense vapour, holding dissolved mineral elements to be subsequently deposited as crystalline species. The above facts serve to show that a solution is really an integral chemical compound, in accordance with the view long maintained by the author.*

19. The law of volumes prevails in all known cases both of homogeneous and heterogeneous integration among gases and vapours, in the changes of oxygen, and of the vapours of iodine and sulphur, as in those of fluorhydric acid, of aldehyd, and of pentine and its polymers, as well as in the not less remarkable condensations or polymerisations of acetylene. All analogy leads us to extend this law to the still greater condensations observed in the denser vapours into which liquid species, above their critical points, are resolvable, and to the further condensation of the vapours into liquid and solid forms—to assume, in fact, that the law of combination by volume, like that of combination of weight (with which, so far as experiment goes, it is indissolubly linked), is universal.

The coefficient of condensation in the case of gases and vapours is readily found by comparing the densities of the respective species at standard temperature and pressure, in the way well known to chemists; the weight of a given volume of hydrogen gas at that temperature and pressure being the unit. For the liquid and solid species formed by the homogeneous integration of these gases and vapours, as we have elsewhere endeavoured to show, the weight of the same volume of the newly formed species at the temperature of its production under the standard pressure is to be taken as the term of comparison, either with that of the vapour or gas calculated for 0° and 760 m.m., or finally, with the weight of an equal volume of hydrogen gas at the same temperature and pressure.

As declared by the writer in 1853, "the doctrine of chemical equivalents is that of the equivalency of volumes"; in other words, the law of volumes, like the law of weights, is universal, and for all species—liquid, solid, or gaseous—the volume, under proper conditions of temperature and pressure, is the same. The volume being then a constant quantity, the integral (or so-called equivalent or molecular) weight of any species, whether gaseous, liquid, or solid, is its specific gravity, hydrogen gas being unity.

20. The advantages to be gained by establishing a single unit for specific gravity, and by substituting alike for water at its maximum density (in the case of liquids and solids) and for air at 0° and 760 m.m. (in the case of gases and vapours), hydrogen gas at the same tempera- and pressure (a plan first indicated in the writer's volume entitled "A New Basis for Chemistry"), were urged in a paper entitled "Chemical Integration," read before the National Academy of Sciences in April, 1887, and published in the *American Journal of Science* for the following August. They were further insisted upon in a paper on "Integral Weights in Chemistry," read before the British Association for the Advancement of Science, at Manchester, in September, 1887, and published in the *London, Edinburgh, and Dublin Philosophical Magazine* for October of the same year. The integral weights of all gases and vapours are evidently their specific gravities, hydrogen being unity; and since water itself is the unit of specific gravity, adopted for convenience, for all liquids and solids, it becomes of the first importance to determine its integral weight. The weight of a litre of hydrogen gas (H_2) at 0° and 760 m.m. being approximately 0·0896 grm., and that of a litre of water at 100° (its temperature of formation at 760 m.m.) 958·78 grms., we have:—

$$0{\cdot}0896 : 958{\cdot}78 :: 2 : x = 21400{\cdot}3.$$

Taking Regnault's figures for hydrogen = 0·089578 grm., the weight of a litre of water vapour ($H_2O = 17{\cdot}96$) calculated for the same temperature and pressure = 0·8044 grm.; we have then:—

$$0{\cdot}089578 : 958{\cdot}78 :: 2 : x = 21406{\cdot}6$$
$$0{\cdot}8044 : 958{\cdot}78 :: 1 : x = 1191{\cdot}9$$

* Read before the National Academy of Sciences, April 17, 1888. Reprinted from the *American Chemical Journal*, vol. x., No. 5.

† Hannay and Hogarth, *Proc. Roy. Soc. Lond.*, xxix., 324, and Chemical News, xii., 103-106; also, "A New Basis for Chemistry," 2nd Edition, §§ 120, 121.

* "A New Basis for Chemistry," §12.

Of these these the last equation gives the coefficient of condensation for water, and if, rejecting the fraction, we assume water to be 1192(H_2O), we have $1192 \times 17{\cdot}96 = 21408$. In the uncertainty which still prevails as to the exact weight of oxygen, hydrogen being unity,* we may safely assume in the calculation of their integral weights from the observed densities of other liquid and solid species, the first-found number, or 21400, as a sufficiently close approximation to the integral weight of water.

21. As regards the further history of the views just stated, it was pointed out in the first edition of the author's "New Basis for Chemistry" (§§ 66, 67) that in applying to water the well-known formula for calculating the so-called atomic volume, $p \div d = v$, while d is its density at 4°, which is the unit of specific gravity for liquids and solids, p is the equivalent weight of its vapour, which is also its density, hydrogen being the unit. Hence the relation of $d : p$ involves the relation of the density of water to that of its vapour, and finally to that of hydrogen gas; and thus enables us to determine the amount of contraction of H_2O in passing from the gaseous to the liquid state, or, in other words, its coefficient of condensation, v being the reciprocal of this coefficient. It was then said, "the question to be settled in fixing the equivalent weight of water is to know its specific gravity as compared with hydrogen gas, or with steam."

In applying this method, the density of steam at 100° as compared with water at 100° having, for the reasons given, occupied the writer's attention, he, by inadvertence, took the densities at this temperature, and was thus led to assign to water the erroneous formula, 1628(H_2O), which, assuming $H_2O = 17{\cdot}9633$, gave an integral weight of 29244. In resuming, however, in §95 of the same volume, the question of the density of liquids and solids taken with water at 4° as unity, it was declared to be "necessary to refer them to a common standard of density, or, in other words, to determine the relation of density between water and hydrogen gas"; d being "the density of water at 4°, and p that of hydrogen at 0°." Soon after in the paper on "Chemical Integration" referred to in §20, it was said that "instead of the weight of atmospheric air at 9° and 760 m.m. . . . as the standard unit of specific gravity for all gases and vapours, hydrogen at the same temperature, which gives us the unit of integral weight, would seem to be the natural unit of specific gravity for all bodies whatsoever"; and again, in comparing the densities of liquid and solid species "with the density of the hydrogen unit, H_2, we get the specific gravity of these bodies, the diad integer of hydrogen at 0° and 760 m.m. being unity." Still further, in the second paper cited in §20, it was said, "hydrogen, as the lightest known species, is the unit of integral weight in chemistry, and a litre of this gas at 0° and 760 m.m. being assumed as a unit of volume for all species, the weight of a litre of any other vapour or gas at the standard temperature and pressure is its integral weight"; while the weight of the same volume for liquids should be taken "at the temperatures at which they are generated by the metamorphosis, through condensation, of the corresponding gaseous species." "In like manner, the weight of solids should, theoretically, be determined at the temperatures at which they are generated by the metamorphosis of gaseous or liquid species"; in other words, we should take for any solid species "the weight of the same volume at the highest temperature at which that species can sustain without undergoing a change of state." Notwithstanding all these repeated statements, the erroneous value for the integral weight of water, calculated by comparing hydrogen gas, water vapour, and water itself, at the common temperature of 100°, was, by an oversight, retained until corrected by the writer in a note on "The Integral Weight of Water" in the *London, Edinburgh, and Dublin Philosophical Magazine* for April, and in the *American Journal of Science* for May, 1888.

22. In the paper on "Integral Weights in Chemistry" was, moreover, considered at some length the relation of the regular thermic changes in volume alike of water and of most solid species to the question of integral weights and specific gravities. It follows from what has been said above that, theoretically, the weight of the volume of water should be taken at 100°, and that of most solids, such as metals, ores, gems, and spars, at temperatures much more elevated. But we have sought to show by comparison of the cubic expansion of water between 4° and 100°, with the much smaller rates of expansion of the solid species in question between 4° and the temperatures of their chemical change by heat, that the resulting errors in the determination of specific gravities at ordinary temperatures to a considerable extent balance each other, and further, that the imperfections and impurities of most natural and artificial species introduce in such determinations "possible deviations in the one and the other direction as great as those due to the different rates of expansion of water and these species, so that we may take the approximate specific gravities got with water at 4° (or better at 15·5°) as an available basis for fixing the integral weights of most solid species."

23. To illustrate alike the mode of calculating the integral weights of solid species, and the use and interrelations of the two standards of specific gravity mentioned above, namely, water at ordinary temperatures and hydrogen gas at 0° and 760 m.m., we may take the case of a crystalline species formed by the condensation of an unknown number of volumes of a theoretical calcium carbonate, $CCaO_3 = 100$. The integral weight of water being in round numbers (§ 20) 21,400, and the specific gravity of the calcareous species (water 1·000) 2·730, we have—

$$21{,}400 \times 2{\cdot}730 = 58{,}422.$$

Dividing the integral weight thus found by that of $CCaO_3 = 100$, we find the number of volumes of this hypothetical carbonate condensed in one volume of the calcareous species, or, in other words, its coefficient of condensation, to be 584·22. Rejecting the fraction, we have for this species, which is calcite, $584(CCaO_3) = 58{,}400$. with a theoretical specific gravity of 2·729.* The relation between the integral weight of the calcium carbonate, $CCaO_3 = 100$ (hydrogen = 1·0, being unity), and the specific gravity of the calcite (water = 21,400, being unity), is got by the equation—

$$2{\cdot}729 : 100 :: 1 : x = \frac{p}{d} = v = 36{\cdot}643.$$

This, the so-called molecular or atomic volume of $CCaO_3$ as it exists in calcite of such density, is the reciprocal of he above coefficient of condensation, since—

$$36{\cdot}643 \times 584 = 21399{\cdot}5.$$

But calcite of this density is 58,400 times heavier than the same volume of hydrogen at 0° and 760 m.m., so that, substituting this value (its specific gravity on the hydrogen basis (for the first term in the above equation, we find the value of v (H = 1·0) to be = 0·0017123, and we have:—

$$1 : 21{,}400 :: 0{\cdot}0017123 : 36{\cdot}643.$$

In like manner, water, 1192(H_2O), taking itself as the unit of specific gravity, gives $v = 17{\cdot}96$, while on the hydrogen basis, with an integral weight of 21,400, we find $v = 0{\cdot}000839$ nearly. But $1192 \times 0{\cdot}000839 = 1{\cdot}00088$.

23. In considering, in 1863, the question of differences in condensation, as exemplified between the various carbon spars, hornblende and pyroxene, fibrolite and cyanite, and especially between meionite and zoisite, it was said, "the augmentation in density, in hardness, and

* *Vide* "The Relative Values of the Atomic Weights of Hydrogen and Oxygen." Cooke and Richards, *American Chemical Journal*, x., 81, and *Proc. Amer. Acad.*, 1887, xxiii.; also Rayleigh, *Proc. Roy. Soc. London*, 1888, xliii., 356.

* The equivalent weight of $CCaO_3$ is here calculated with O = 16, substituting for which the value O = 15·96, we have instead of 100 the number 99·88. This gives for $584CCaO_3$, instead of 58400, an integral weight of 58,330, corresponding to a specific gravity of 2·7357 instead of 2·7290, a difference so small that it may be neglected as within the limits of error.

in chemical indifference which is seen in this last species [as compared with meionite] is doubtless to be ascribed to a more elevated equivalent, or, in other words, to a more condensed molecule."* Again, in 1867, in discussing these and other examples in mineral species, it was said, "the hardness of these isomeric or allotropic species, and their indifference to chemical reagents, increase with their condensation, or, in other words, vary inversely with their empirical equivalent volumes, so that we here find a direct relation between chemical and physical properties."† The conclusion then reached was, in fact, that for related solids, hardness and chemical indifference increase with the condensation of the species, or, in other words, vary *inversely* as their empirical equivalent or so-called atomic volumes, represented by v:—

$$\frac{\text{atomic weight}}{\text{specific gravity}} = \text{atomic volume} = \frac{p}{d} = v.$$

This is in accordance with the earlier observations as to the tenacity and hardness of metals and alloys. Wertheim, from his experiments, concluded (as Guyton Morveau had long before) that the order of the common metals for tenacity and for hardness is practically the same, and announced in 1841 that the tenacity varies *directly* as the quotient of the specific gravity divided by the atomic weight:—

$$\frac{\text{specific gravity}}{\text{atomic weight}} = \frac{d}{p} = \frac{1}{v}.$$

This conclusion was confirmed by the studies of Calvert and Johnson, in 1859, on the hardness of metals and alloys; by those of Karmarsch on the tenacity of metallic wires; and by those of Bottone, in 1873, also on the hardness of metals; the latter maintaining that for homogeneous bodies of uniform texture, hardness and tenacity vary together in accordance with the law enunciated by Wertheim.‡ The law thus arrived at by various investigators for the hardness and tenacity of metals and alloys is identical with that independently deduced by the author, not only for the hardness but for the indifference to chemical changes, of related silicates, carbonates, and oxides.

24. We have sought in the preceding pages to set forth and to explain what may be regarded as the fundamental facts of chemistry, by an extension of the well-known and verified laws of combination by weight and volume. In doing this it has not seemed necessary or in any way advantageous to invoke the aid of the atomic hypothesis. This, which was adopted in 1808 by Dalton to explain the facts of definite and multiple proportions observed in chemical changes, has since been greatly extended and modified in the effort to apply it to many phenomena then unknown. Molecules being assumed to be built up of atoms, it is supposed, in the language of Lothar Meyer, one of the most able and learned exponents of the hypothesis, that while "each monovalent atom possesses only a single position in space by which another atom can be held by it in stable equilibrium," the polyvalent atoms may have "four, five, or six such positions," or points in space. The atoms themselves "are in a state of active motion, with these points as centres of equilibrium. The motion may be rotary or oscillatory. In those cases in which an atom fills two or more of these points it is considered to oscillate between, or, rotating, to pass through these centres." These atoms are furnished with "bonds," "links," or "hooks," and are joined together by various modes of "atomic linking" both single and double, forming "rings," "chain-like groups," "open chains," "closed chains," "branched chains," &c. Thus, for example, "a branched series of atoms is obtained, composed of several linear chains. In the same way these branches can also divide, and the new branches may be united together by connecting links, forming ring-like or net-like structures." The author, however, tells us in a footnote that the expression "ring-shaped" "need not be accepted as applying to space; it only indicates that the attractions between the atoms which maintain the coherence of the molecule form a continuous series."* In like manner Prescott states that "in the use of the chemical term, position," he will be understood to refer "not to arrangement in space, but to the order of the union of the atoms with each other."† Another distinguished American chemist has, however, lately assured us that the question of "atom-grouping has a mechanical as well as a chemical side," and, notwithstanding the provisos above quoted, it seems impossible to divest the language which we have quoted from Lothar Meyer of a geometrical sense. Without speaking of the fancies of earlier writers as to the architecture of molecules, it is well known that Le Bel and Van't Hoff have speculated upon the supposed arrangement of the atoms of molecules in space, and that Wislicenus has lately made a further contribution in the same direction towards a hypothesis of the geometry of molecules."‡

25. By such assumptions as the foregoing the modern atomistic chemistry seeks to explain the physical and chemical characters of species, which it regards as dependent upon forces and properties supposed to dwell in the individual atoms from which these are conceived to be built up. Structural formulæ in accordance with this hypothesis may serve to explain the facts of definite and multiple proportions, of polymerism in vapours, and of the peculiar differences presented by such isomeric bodies as the primary, secondary, and tertiary alcohols, $C_nH_{2n+2}O$. Assumed differences in "the order of the union of atoms with each other" may be made to account for the unlike genetic relations presented in their chemical changes by certain of these isomeric species, but there are other phenomena which it will require still further and purely gratuitous assumptions to explain by the atomic hypothesis. Such, for example, are the subtle differences which divide the amylic alcohol got by fermentation into two species, one optically active and the other inactive. These, though convertible the one into the other, present also minor chemical distinctions, and, moreover, transmit their optical characters to the derived valeric acids.§ Similar chemical and optical unlikenesses appear in the limonenes, pinenes, and camphenes, which are all apparently isomers of dipentine; and other examples of optical, crystalline, and chemical differences meet us frequently in the study of isomeric and homologous bodies, which can hardly be explained by any constitutional or so-called structural formulæ.

To indicate the essential differences which distinguish two substances having, it may be, the same centesimal composition and the same density, alike in the vaporous and the liquid or solid state, as in the instances above noted, they have been said by different writers to be unlike in "structure," or in "organisation." The term structure, however, implies that the substance in question is put together or is built up by a certain arrangement of parts, while the term organisation superadds the conception of such a subordination of parts to function as belongs to crystalline or to biotic structures. For these

* *Comptes Rendus*, June 29, 1863, and in English, *Amer. Jour. Science*, xxxvi., 426.

† *Amer. Jour. Science*, xliii., 203. See further, "A New Basis for Chemistry," Chapter VII., and also Appendix to the 2nd Edition.

‡ See, in this connection, "The Hardness of Metals," by Thomas Turner, Chemical News, April and May, 1887. It may here be remarked that compounds of metals with sulphur, phosphorus, carbon, and silicon often differ greatly, alike in dynamical and in chemical characters, from the metals themselves, as may be seen in the increased hardness and tenacity of certain compounds containing even small portions of some of these elements (§ 13).

* All the expressions here quoted are from the chapter on the Law of Atomic Linking, in the late excellent translation by Bedson and Williams of the 5th edition of Lothar Meyer's "Die Modernen Theorien der Chemie" (Longmans, 1888).

† Prescott, "The Chemistry of Nitrogen," *J. Amer. Chem. Soc.*, Sept., 1887, 133.

‡ See *Amer. Chem. Journ.*, ix., 453.

§ See on this subject the studies of Pasteur, Fedler, and Chapman and Smith; "Watts's Dict. of Chemistry," 1st Supplement, *sub voce* Amyl Alcohols.

reasons it is conceived that the term "constitution," which implies no mechanical hypothesis, but simply refers to the character or the *essential form* of the species in question, is to be preferred. Chemical species are subject to constitutional changes, or, in the language of Andrews, to "internal disturbances," which alter to greater or less degrees alike their dynamical and their chemical relations. Such constitutional changes may manifest themselves in veritable metamorphosis by homogeneous integration or disintegration, and consequent change in integral weight; or in other cases by such slighter differences as have been signalised in the amylic alcohols and the various dipentines; or as are seen in certain cases of crystalline dimorphism, which are apparently independent of any change in density. Were it possible to establish on valid grounds the existence of chemical molecules, built up by the putting together of the atoms in the fantastic arrangements supposed by the present highly complicated atomic hypothesis, further assumptions would still be required to account for these minor constitutional differences. Something radically different from this or any other mechanical hypothesis must, in the writer's opinion, be devised before we can hope to explain adequately the dynamical and chemical history of matter. Signs are not wanting that this famous hypothesis, so generally accepted by chemists since Dalton's time, is felt by many to be no longer adequate, and that, in the language of J. P. Cooke, it may be regarded as "only a temporary expedient for representing the facts of chemistry to the mind.*" The fate which befell the corpuscular hypothesis of light, and now seems to menace the undulatory hypothesis, appears to await the atomic hypothesis in chemistry.

THE ACTION OF CHLORINE ON THE LIGNO-CELLULOSES.

By C. F. CROSS and E. J. BEVAN.

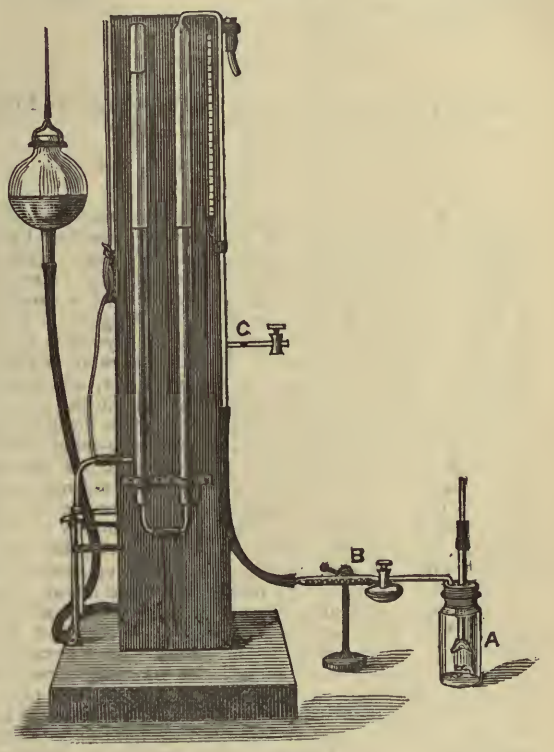
We have recently made a quantitative study of the chlorination of the ligno-celluloses, using a method and apparatus which may be found to have other application in cases in which it is required to determine the volume of a gas disappearing in combination. We anticipate the publication of the particular results of this research by the following brief description of the apparatus and method.

A is the flask or bottle in which the reaction takes place. It is closed by a cork (of indiarubber well coated with paraffin) through which pass two tubes, the first of narrow bore, bent at right angles, carrying a stop-cock, and serving to connect the flask with the measuring apparatus; the second is a piece of wide tubing, blown out below to a relatively large and thin-walled bulb. Into this bulb the fibre, suitably prepared, is introduced. Outside the cork a piece of rubber tubing is passed over the extremity of the tube, and through this a piece of rod, of somewhat less diameter than the tube, is pushed until it presses upon the fibre in the bulb.

B is a tube containing a substance capable of combining with chlorine—*e.g.*, a small quantity of the fibre itself—inserted between the flask and measuring apparatus, serving to indicate any transfer of chlorine from the flask by diffusion, should such take place; this, however, we have not found to occur.

The bottle is filled with chlorine by displacement over water, inverted, and the cork carrying the bulb-tube with the fibre is inserted; the stop-cock on the other tube is closed and the connection made as in the figure. When the bottle has attained the temperature of the room the levels in the measuring apparatus are adjusted to the lowest graduation of the instrument, with both stop-cocks open. The stop-cocks are then closed, and the bulb in the reaction flask is broken by pressure on the rod. The latter is opened, and mercury is continuously run in to keep pace with the movement in the right hand limb of the measuring apparatus, which corresponds with and measures the chlorine disappearing.

Such a method is open to obvious sources of error, the chief of which is the *absorption* of chlorine by the fibre and the water which it contains. The volume disappearing in combination, on the other hand, is relatively large; *e.g.*, in one experiment in which 1 grm. of jute was taken it



amounted to 60 c.c. (at 18° and 758 m.m.). That the method is trustworthy is shown by the satisfactory agreement of the numbers in a series of experiments, and further by the coincidence of these numbers with those calculated from the HCl formed (and determined by titration).

The results obtained have thrown light on the molecular constitution of the ligno-celluloses, and will be discussed in a paper about to be communicated.

* *American Journal of Science* (1883), xxvi., 310 to 316.

SILICON HYDRIDE.

By H. N. WARREN, Research Analyst.

Requiring a somewhat large quantity of amorphous silicon, I made use of the following ready method of preparing the same, namely, by the action of gaseous silicon fluoride upon metallic magnesium, contained in an ordinary combustion tube, and heated by the aid of a gas flame. The products being amorphous silicon, magnesium fluoride, and a small quantity of a peculiar form of magnesium silicide, which, when exposed to the action of the more concentrated acids, and especially hydrochloric, evolved a most spontaneously inflammable silicon hydride; this, when in contact with the atmosphere, takes fire with explosive violence, the nature of its combustion resembling in every respect that of phosphoretted hydrogen.

The same gas may, however, be obtained free from spontaneous inflammability by reacting on the above-mentioned compound with the weaker acids, such as acetic and oxalic, but the difficulty arising from freeing it from uncombined hydrogen gas renders it impossible to speak definitely, although from various experiments that have been performed with the same, it would appear to be closely allied to hydric phosphide, and to be a mixture of silicon hydride, both in the gaseous, liquid, and solid form.

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SELECTIVE ABSORPTION OF METALS FOR ULTRA VIOLET LIGHT.*

By JOHN TROWBRIDGE and W. C. SABINE.

The question of the absorption of the ultra violet rays by metallic surfaces possesses considerable interest, both from a practical and a theoretical point of view. By the kindness of Prof. Pickering, Director of the Harvard University Observatory, we were provided with a number of metallic surfaces prepared by Prof. Wright, of Yale College. These metallic surfaces were deposited upon glass by means of electricity. The surfaces were of gold, platinum, tellurium, palladium, copper, silver, and steel. A preliminary trial had shown us that a heliostat mirror of the same composition as that upon which the grating was ruled did not absorb light of greater wave-length than 2900. We resolved, therefore, to compare other metals with speculum metal. Since our heliostat arrangement required two mirrors to direct the light upon the slit of the spectroscope, we employed a speculum mirror for the movable mirror of the heliostat, and replaced the fixed mirror by mirrors of the metals whose selective absorption we wished to compare with that of speculum metal. To our surprise the metallic mirrors of gold, copper, nickel, steel, silver, tellurium, and palladium all reached the same limit as speculum metal. Here was a complete experimental proof that colour in no way influences the selective absorption of metals for the ultra violet rays; for the copper mirror, which gave a strong yellow light by reflection, was as capable of reflecting light of as short wave-length as the brilliant white surface of polished silver. Although the metallic surfaces we employed were bright, slight differences in polish undoubtedly existed, and therefore we are not justified in placing much reliance upon the evidence presented by the intensity of the photographs of the solar spectrum obtained by light reflected into the spectroscope by these various metallic surfaces. The photographs, however, can be classified according to intensity in order of numbers as follows:—number 1 indicating the greatest intensity: 1, steel; 2, gold; 3, platinum; 4, palladium; 5, silver; 6, tellurium; 7, copper.

It was evident from these experiments that the selective absorption of metals is far less than the absorption exercised by the earth's atmosphere. We therefore resolved to employ the light of the electric spark between metallic terminals, in order to ascertain whether any limit of absorption could be reached. For this purpose, the light of the spark between copper terminals was reflected, by means of a mirror of the metal whose selective absorption we wished to examine, upon the slit of the spectroscope. To protect the surface of the mirror from the effects of the spark, a thin plate of quartz was placed in front of it. It was found that the copper mirror showed no limit of selective absorption by reflection for wave-lengths of light produced by burning copper at the limits of the copper spectrum, that is, at wave-length 2100. The photographic plate taken by this method showed all the lines that the plates showed which were taken by the direct light of the spark unreflected and unabsorbed by any medium. The palladium mirror was substituted for the copper mirror, and also showed no limit of selective absorption above wave-length 2100. We are led to conclude, therefore, that the metallic surface of the speculum metal upon which the lines are ruled which form the diffraction grating does not fix by selective absorption the limit of metallic spectra at 1800 to 2100. This limit more likely resides in the materials forming the sensitive emulsion with which the sensitive plates are coated. We have found that a marked difference exists in different emulsions in regard to sensitiveness to ultra-violet light. The various staining processes, which enhance to such a marked degree the sensitiveness of photographic plates to wave-lengths of greater length, do not seem to affect the limit of metallic spectra in the ultra-violet. Thus, plates stained with erythosine, which are extremely sensitive to yellow and green light, continue to give the same limit in the ultra-violet after staining as they did before they were submitted to the staining process.—*Proceedings of the American Academy of Arts and Sciences.*

* Contributions from the Jefferson Physical Laboratory.

THE ESTIMATION OF QUININE BY KERNER'S METHOD.

By EDSEL A. RUDDIMAN.

(Continued from p. 204).

(3) *Experiments to Determine the Accuracy of Kerner's Figures.*—For the quantitative estimation of cinchonidine sulphate in quinine sulphate by his ammonia test, Kerner* gives figures obtained for the fraction of 1 c.c. of water of ammonia, sp. gr. 0·920, which 1 m.grm. of cinchonidine requires to dissolve it, varying from 0·288 to 0·350 c.c. His method of experimentation in brief is as follows:—To 50 c.c. of standard quinine sulphate solution, prepared by digesting chemically pure quinine sulphate in water at 15° C., and filtering, he adds a weighed quantity of cinchonidine sulphate, varying the amount added, This solution, in portions of 10 c.c., is then titrated with ammonia water of sp. gr. 0·920. Simultaneously with this, 50 c.c. of the standard solution are titrated in portions of 10 c.c. each. The excess of ammonia used in the former case over that used in the latter is divided by the number of m.grms. of cinchonidine sulphate contained in 10 c.c. of the former solution. This will give the amount of ammonia water necessary to dissolve 1 m.grm. of the cinchonidine salt. According to this method I made twenty-five experiments as given below, varying the amount of cinchonidine sulphate from 0·005 grm. to 0·05 grm. for every 50 c.c. of the standard solution.

Three experiments (I., VIII., XIII.) were made to find the number of c.c. of the ammonia water taken by the standard quinine sulphate filtrates alone. This number of c.c. was deducted from the reading in each following experiment with cinchonidine addition; thus the 6·385 c.c. obtained in I. was deducted from the readings in experiments II. to VII. for the calculations to give the figures of the last column.

In each experiment I took the average of four titrations; then taking the average of the twenty-five experiments, covering one hundred titrations, I found that for every m.grm. of cinchonidine there was required 0·360 c.c. of ammonia water of sp. gr. 0·920 to dissolve the precipitate. In the following experiments the temperature of the resulting solution of each titration was taken as soon as the titration was completed. When the temperature thus taken varied from 15° C., due allowance was made by

* 1862; *Zeitsch. Anal. Chem.*, xx., 150. *Pharm. Jour. and Trans.*, July, 1862. *Am. Jour. of Pharm.*, xxxiv., 217. 1880; *Archiv. der Pharm.* [3], xvi., 186. *Jahresb. der Pharm.*, 1880, 161. *Pharm. Jour and Trans.* [3], xi., 27. 1880; *Archiv. der Pharm.* [3], xvii., 438. *Proc. Am. Pharm. Assoc.*, xxix., 329.

adding or subtracting for every degree of increase or decrease, as the case might be, 0·148 c.c. to or from the amount of ammonia used. In order to secure constancy in composition of the cinchonidine salt taken, the cinchonidine sulphate was exposed to the air until thoroughly effloresced and then weighed as having the formula $(C_{19}H_{22}N_2O)_2H_2SO_4 \cdot 2H_2O$. From this the equivalent quantity of the crystallised salt ($6H_2O$) was calculated. The following abbreviations are used in the table below:—S. Q. S. S. for standard quinine sulphate solution; am. for ammonia water; ef. cin. sulph. for effloresced cinchonidine sulphate.

No. of the Experiment.	To 50° c.c. of S. Q. S. S. add of Ef. Cin. Sulph.	No. of c.c. of Am. for 10 c.c. of the Quinine Solution.	Temperature of each Titration when made.	Average No. of c.c. of Am. used at 15° C.	1 M.grm. of Crystal Cin. Sulph. takes of Ammonia.
I.		6·1	16°	6·385	
		6·3	,,		
		6·2	,,		
		6·2	,,		
		6·3	,,		
		6·2	,,		
		6·3	,,		
		6·3	,,		
II.	0·00454 grm.	6·3	18°	6·744	0·359 c.c.
		6·4	,,		
		6·2	,,		
		6·3	,,		
III.	0·00454	6·3	18°	6·746	0·360
		6·7	16		
		6·4	17		
		6·25	18		
IV.	0·01354	7·1	18°	7·444	0·353
		7·2	,,		
		6·9	,,		
		6·8	,,		
V.	0·01354	6·9	18°	7·444	0·353
		7·1	,,		
		7·0	,,		
		7·0	,,		
		7·0	,,		
VI.	0·01818	7·5	17°	7·845	0·368
		7·6	,,		
		7·5	,,		
		7·5	18		
VII.	0·02275	8·0	17°	8·232	0·369
		7·8	18		
		7·8	,,		
		7·7	,,		
VIII.		6·1	15°	6·140	
		6·2	,,		
		6·0	16		
		5·9	,,		
		5·9	17		
		5·7	18		
		5·7	,,		
		5·7	,,		
IX.	0·00454	6·3	17°	6·491	0·351
		6·2	16½		
		6·25	16		
		6·4	16		
X.	0·00909	6·8	15°	6·750	0·305
		6·7	,,		
		6·7	,,		
		6·8	,,		
XI.	0·00909	6·8	16°	6·82	0·340
		6·7	,,		
		6·6	,,		
		6·6	,,		
XII.	0·01354	6·9	16°	7·112	0·324
		7·2	15		
		7·1	,,		
		7·1	,,		
XIII.		6·6	15°	6·50	
		6·3	,,		
		6·4	,,		
		6·65	,,		
		6·4	,,		
		6·65	,,		
		6·6	,,		
		6·6	,,		
		6·3	,,		
		6·5	,,		
XIV.	0·01354	7·0	15°	7·0	0·388
		7·0	,,		
		7·0	,,		
		7·0	,,		
XV.	0·01818	8·1	15°	7·975	0·368
		8·0	,,		
		7·9	,,		
		7·9	,,		
XVI.	0·01818	7·9	15°	7·975	0·368
		8·0	,,		
		8·1	,,		
		7·9	,,		
XVII.	0·02275	8·3	15°	8·3	0·360
		8·4	,,		
		8·2	,,		
		8·3	,,		
XVIII.	0·02275	8·4	15°	8·3	0·360
		8·3	,,		
		8·3	,,		
		8·2	,,		
XIX.	0·02727	8·4	15°	8·662	0·360
		8·8	,,		
		8·8	,,		
		8·5	16		
XX.	0·02727	8·7	15°	8·725	0·370
		8·6	,,		
		8·8	,,		
		8·8	,,		
XXI.	0·03182	9·3	14½°	9·106	0·372
		9·2	15		
		9·1	,,		
		8·9	,,		
XXII.	0·03182	9·1	16°	9·198	0·385
		9·2	,,		
		8·9	,,		
		9·0	,,		
XXIII.	0·03637	9·6	15°	9·375	0·359
		9·2	,,		
		9·4	,,		
		9·4	,,		
XXIV.	0·03637	9·6	15°	9·450	0·368
		9·4	,,		
		9·4	,,		
		9·3	,,		

No. of the Experiment.	To 50 c.c. of S. Q. S. S. add of Et. Cin. Sulph.	No. of c.c. of Am. for 10 c.c. of the Quinine Solution.	Temperature of each Titration when made.	Average No. of c.c. of Am. used at 15° C.	1 M.grm. of Crystal Cin. Sulph. takes of Ammonia.
XXV.	0·04191	9·7	16°	9·877	0·376
		9·9	15		
		9·9	"		
		9·9	"		
XXVI.	0·04191	9·8	15°	9·8	0·366
		9·8	"		
		9·9	"		
		9·7	"		
XXVII.	0·04546	10·2	16°	10·324	0·382
		10·3	"		
		10·3	15		
		10·2	"		
XXVIII.	0·04546	10·3	15°	10·336	0·383
		10·3	"		
		10·2	17		
		10·1	16		

Taking the average result of the twenty-five experiments I found that 1 m.grm. of cinchonidine sulphate $[(C_{19}H_{22}N_2O)_2H_2SO_4 \cdot 6H_2O]$, when dissolved in a solution of quinine sulphate, requires 0·36 c.c. of ammonia water of sp. gr. 0·920 to precipitate and re-dissolve it.

(4) *Method for Quantitative Estimation.*—Kerner's* method and claims for the quantitative estimation of cinchonidine sulphate in commercial quinine sulphate are here given in a faithful translation as follows:—Five grms. of the salt to be examined are rubbed in a mortar with distilled water to a homogeneous mass, then transferred to a stoppered flask, rinsing with enough water so that in all 50 c.c. are used. The mixture is then either placed in water (of about 50° C.), shaken vigorously and cooled, or digested without heating for twelve to eighteen hours, shaking vigorously and frequently. The flask is now placed in cold water, together with the mixture of standard quinine and water for comparative titration and the ammonia water, and when all are at the same temperature the quinine solutions are filtered through dry filter papers. The temperatures of the air and water taken into consideration in the operation lie between 12° and 24°. For the absolute numerical titre they are not indifferent, but for the relative result they are. The preservation of a fixed low temperature is not necessary if the standard quinine solution is prepared and filtered at the same temperature. As a measuring instrument for the ammonia, a long burette finely divided (1—20 c.c.) is used. The saturated quinine sulphate solution is measured with an exact 10 c.c. pipette into a test-glass, and the titration is carried on as follows:—5 c.c. of ammonia water are added from the burette to 10 c.c. of quinine solution, the test-glass then closed with the finger and gently turned two or three times without shaking. The greater part of the quinine is now precipitated and re-dissolved, but the fluid is still distinctly turbid. The ammonia is now added in small portions (3—10, 2—10, 1—10 c.c.), and each time after gently turning it is observed whether complete clearing follows or not. On each addition of the ammonia it is well to wait five or ten seconds before adding more. After some experience the end reaction—the complete clearing up of the solution—may be discerned with great accuracy. If 5 grms. of the sulphate are treated with 50 c.c. of water, and 40 c.c. filtrate be obtained, there will be sufficient to make four titrations, of which the average result may be taken. The simultaneous titration of the standard quinine solution gives the exact titre of ammonia, and the excess used over this to obtain the solution of the quinine sulphate under examination indicates the amount of cinchonidine present more exactly than is determined by any gravimetric method. As seen from the analytical results (Kerner's), 0·288 c.c., or in round numbers 0·3 c.c., of ammonia water sp. gr. 0·920 corresponds to one m.grm. of crystallised cinchonidine sulphate in one grm. of the sulphate of quinine tested. And as the possible mistake in observation amounts to only 0·1 c.c., or at the highest 0·15 c.c., closer readings could hardly be wished for than those of the titration method, while an error of more than 1·30 per cent to 1·20 per cent does not need to happen. It is to be observed that the examination of only the quinine sulphate, which passes the definition of the officinal test, or rather that which does not contain more than 1—1·5 per cent of cinchonidine sulphate, is taken into consideration. If an aqueous mixture in the proportion of 1:10 be prepared from a sulphate of quinine containing more than 2 per cent of cinchonidine sulphate, the estimation is inaccurate because the filtrate then contains so large a proportion of foreign alkaloids that the end reaction is obscured. The addition of the ammonia in such a case causes either a large flaky precipitate difficult to re-dissolve, or, during the addition of ammonia near the point of clarification, a greater turbidity suddenly occurs, so that on standing it becomes gelatinous and on that account the end reaction is not distinct. This inconvenience is entirely avoided if, after noting the kind and intensity of the turbidity by the qualitative test, either the 1 : 10 prepared mixture is diluted with a definite amount of standard quinine solution, or, if a higher proportion of water be used in the preparation of the saturated solution, 1 part of the salt to 50, 100, 200, &c., parts of water.*

Mention has been made of the fact that, by digesting commercial quinine sulphate in 10 parts of water at 15° C., the cinchonidine sulphate is not all dissolved. Now since by digesting it at a warmer temperature the filtrate indicates a higher per cent of cinchonidine; to estimate as nearly as possible the amount of cinchonidine, all of the quinine should be dissolved. It seems then as though Kerner's method of estimation should be modified so that all of the salt shall be dissolved. This may be done by digesting the quinine sulphate in 30 parts of water at 100°, cooling, digesting at 15° for two hours, and filtering. To portions of the filtrate apply the test as given by Kerner. In calculating the amount of cinchonidine sulphate, allowance must be made for the dilution caused by using 30 c.c. instead of 10 c.c. of water for digestion. It is not claimed that all of the cinchonidine is estimated by this method, for no doubt some of it crystallises out again with the quinine. Hesse says that two crystallisations are necessary to remove all of the cinchonidine, while others maintain that four or five crystallisations are necessary.

In working with one sample of commercial quinine sulphate I estimated the amount of cinchonidine sulphate according to Kerner's method, and found the indication to be 1·2 per cent. In using the same proportion of the salt and water, but by digesting at 100°, then cooling, digesting at 15°, and filtering on adding ammonia water, the end reaction could not be determined accurately on account of the gelatinous precipitate which forms when there is much over 2 per cent of cinchonidine sulphate present. Now on treating a portion of the same sample with 30 parts of boiling water, cooling, digesting at 15°, filtering, and applying the test, it indicated 6·3 per cent of cinchonidine sulphate present in the quinine sulphate.

In working with a sample of quinine sulphate made by another manufacturer, according to Kerner's method of estimation, that is by digesting the salt with 10 parts of water at 15°, the result indicated 2·2 per cent cinchonidine. When the same salt was digested with 30 parts of boiling water before applying the test to the filtrate, an indication of 5·9 per cent of cinchonidine sulphate was obtained.

(To be continued).

* 1880; *Archiv. der Pharm.* [3], xvi., 186.

* This report of Dr. Kerner in 1880 is presented at length because it does not appear to be accessible in our language.

NOTICES OF BOOKS.

A Class Book of Elementary Chemistry. (Clarendon Press Series). By W. W. Fisher, M.A., F.C.S., Aldrichian Demonstrator of Chemistry. Oxford: Clarendon Press.

This is one of the numerous elementary scientific treatises which are a source of perplexity to the reviewer. It would be a hard task to find anything here to which objection might be taken without a degree of hypercriticism. On the other hand it would be no less hard to discover any well-marked advantage which the class-book before us possesses as compared with others of its kind. To us it seems that until some important step in the fundamental principles of the science has been taken there is no room for any more manuals or handbooks.

Outlines of Qualitative Analysis. By A. Humboldt Sexton, F.I.C., F.C.S., F.R.S.E. London: C. Griffin and Co.

Autumn generally brings with it a crop of elementary works on chemistry whose *raison d'être* it is not always easy to discover. The author, admitting that existing manuals of analysis are not few, divides them into two classes. On the one hand there are treatises like those of Fresenius, Rose, and others, intended principally as works of reference for the advanced student and the professional analyst. On the other there are small books adapted to some "syllabus," and religiously avoiding whatsoever lies outside such limit. Between these two extremes the author endeavours to steer a middle course.

Professor Sexton has the good sense not to follow any syllabus in the preparation of his book, but he points out certain sections to which students preparing for the examinations of the "Department" may confine their attention.

CORRESPONDENCE.

ANCIENT MORTARS.

To the Editor of the Chemical News.

Sir,—The short but interesting paper by Mr. John Spiller, F.C.S., in the Chemical News (vol. lviii., p. 189) on the "Ancient Mortar from the Roman Wall of London," raises a question of some theoretical importance. The remarkable occurrence of nearly 11 per cent of soluble silica in this mortar and in that of the Roman bath at Bath, suggests certainly the possibility of the synthesis of silicate of lime by simple saturation of the ingredients with water during a space of some eighteen centuries. Now we know that silica, which is so inert a body under ordinary physical conditions, is at high temperatures one of the most potent bodies in nature; and silicate of lime can be formed by fritting together lime and clean quartz sand. I have seen specimens of wollastonite which were made some years ago in this way in Dr. Percy's laboratory. But have we any right to infer from this the probability of its formation under the circumstances described in the paper referred to? I think not. It seems far more likely that the soluble silica occurred in the form of easily-decomposable silicates, which are found in a more or less vitreous condition in the pumiceous tuffs (such as possuolana), which are extensively worked for "hydraulic mortar." But we need not suppose such materials to have been imported from Italy. They are formed much nearer home in the *trass* of the Brohlthal and the Nettethal in the Vorder Eifel. That the Romans were familiar with such a use of the material in question we know from the writings of Strabo. The city of Pateoli "had artificial wharfs for ships, for the construction of which the sand of the place, mixed with lime, is remarkably adapted from its speedy solidification." The trass of the Vorder Eifel has been worked for centuries, and transported in barges down the Rhine to Holland, where it is used for purposes similar to that mentioned by Strabo; and what we know of the engineering capacities of the Romans leads to the belief that they would have recognised the value of the trass for such purposes. Is it not possible that the material may have been brought thence to London, and even to Bath?

If Mr. Spiller were to obtain the aid of a competent petrologist or mineralogist in the microscopic examination of his HCl residues, some new light might be thrown on this interesting question.—I am, &c.,

A. Irving.

Wellington College, Berks,
October 26, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Bulletin de la Société Chimique de Paris.
Vol. xlix., No. 12, June 20, 1888.

Researches on Porcelains known as "Craquelées."—C. Lauth and G. Dutailly.—This paper, though evidently of great importance to the porcelain trade, does not admit of useful abstraction.

On the Various Modes of Explosive Decomposition of Picric Acid and Nitro-compounds.—M. Berthelot.

The Graduation of Tubes intended for Gazometric Measurements.—M. Berthelot.

On the "Collection of Ancient Greek Alchemists."—M. Berthelot.

Metallic Arsenic known to the Ancients.—M. Berthelot.—These papers have been already noticed.

Decolouration of Tincture of Litmus in Closed Vessels.—M. Dubois.—It is known that tincture of litmus kept in a closed vessel soon turns paler, and is completely decolourised, the blue colour reappearing on exposure to air. On microscopic examination it is found that the tincture contains a Flora and a Fauna consisting of infusoria, zoospores, algæ, fungi, in short, microbia of different species. To ascertain if these organisms were not the efficient agents in the decolouration of the tincture, the author placed, on Feqruary 15th, three samples of tincture of litmus, all from the same source, in three glass bottles. Two of the bottles were sterilised, the one by mercuric chloride, the other by heat, and both were sealed at the lamp. The third bottle was merely sealed, and all three contained a small store of air. The specimen in the non-sterilised vessel quickly lost its blue tint, and became of a vinous red, and by May 1st it was completely decolourised. In the other bottles, though exposed to the light, the blue colour did not vary. The microbe to which this change is due is a very small micrococcus, generally found arranged in groups of four.

Vol. l., No. 1, July 5, 1888.

Researches on Drainage.—M. Berthelot.

On Certain General Conditions of the Fixation of Nitrogen by Vegetable Soil.—M. Berthelot.

The Condition of Potassa in Plants, in the Earth, and in Vegetable Soil, and on its Determination.—MM. Berthelot and André.

On Phosphorus and Phosphoric Acid in Vegetation.—MM. Berthelot and André.

The Condition of Sulphur and Phosphorus in Plants, in the Earth, and in Soils, and on their Determination.—MM. Berthelot and André.

The Absorption of Saline Matters by Plants.—MM. Berthelot and André.—The subject-matter of these memoirs has been already noticed.

Action of Hydriodic Acid upon Allyl Iodide.—H. Malbot.—The author concludes that in this reaction there is the preliminary formation of a large quantity of propylene iodide, which iodide, under certain circumstances, may either be converted into isopropyl iodide without a liberation of propylene, or may be split up into propylene and iodine without formation of iodine and isopropyl. Thus, the ultimate product of the transformation of allyl iodide may be either isopropyl iodide or propylene.

The Crystalline Water of the Alums.—MM. Lescœur and Mathurin.—Alums are generally considered as containing twenty-four equivalents of crystalline water. This is contested by M. Maumené, who ascribes to potassium alum as much as twenty-nine equivalents. M. de Boissieu has undertaken to re-determine the crystalline water of potassium and chromium alums, and has obtained results ranging between 23·6 and 24·1 equivs. As the methods which he employed seemed open to objection, the authors have taken up the question anew, and conclude that the products analysed contain 24 equivs. of water. Further researches proved that the specimens analysed were not mixtures, but perfectly definite compounds not altered by efflorescence.

Remarks on the Observations of M. Maumené.—J. M. Crafts.—M. Maumené declares that a method for purifying mercury, given in the *Bulletin* (vol. xlix., p. 898), had been previously indicated by Berzelius, and afterwards by himself. In the passage cited Berzelius says merely that he had obtained a plumbous oxide by dissolving lead in mercury through which was passed a current of air, but he does not recommend the process for the purification of mercury, either in his contribution to the *Annales* (? *Annalen*), or in his treatise on chemistry. The writer admits that M. Maumené has the priority as regards the principle of the purification of mercury by agitation with air. He conceives, however, that he has suggested a more convenient means of carrying out the process than that proposed by M. Maumené.

The Compound Nature of the Elements.—E. Allary.—In support of his hypothesis on chlorine and cyanogen *Bulletin* (May 20, 1888), the author cites Victor Meyer as having partially decomposed chlorine into oxygen and an unknown substance (?). The experiment of Meyer is described in full in a memoir by Sir B. Brodie, which may be found in the *Moniteur Scientifique* (1880, p. 539). The memoir of M. Lockyer (*Moniteur Scientifique*, March, 1879) likewise proves the compound nature of certain elements.

Determination of Para-nitrotoluene.—F. Reverdin and Ch. de la Harpe.—The authors first prepare an absolutely pure ortho-nitrotoluene, and effect the determination as follows:—They sulphonise the nitrotoluene in question and a nitrotoluene containing exactly 4 per cent of the para-compound. They pour the product of the sulphonation into water, dilute to 200 c.c., and compare the colour reactions which 1 c.c. of each of these liquids yields with 5 c.c. of a solution of caustic soda at $\frac{1}{10}$. If the sample gives a redder colour we take a measured quantity of it (20 or 50 c.c.) and dilute progressively until 1 c.c. of the dilute liquid, heated with 5 c.c. of the solution of soda, gives the same colouration as the standard at 4 per cent. The number of c.c. thus added to arrive at this result is noted, and we calculate to what volume the original 200 c.c. must be brought to obtain the same colouration. The authors have found by this method that the nitrotoluene of commerce contains, in general, a little more than 4 per cent of the para-compound. When operating on known mixtures of the ortho- and para-modifications, they have always, for mixtures containing less than 20 per cent of para-, obtained results falling within 0·5 per cent of the theoretical proportions.

New General Method for the Separation and Volumetric Determination of Acids.—G. Linossier.—This method is applicable to all the acids capable of forming an insoluble compound with any of the metals precipitable by sulphuretted hydrogen. The acid is separated from the solution by causing the formation of such an insoluble compound, which is then decomposed by means of sulphuretted hydrogen, and the acid thus liberated is determined directly by acidimetry, either after the sulphuretted hydrogen has been eliminated by boiling, or by using an indicator not affected by that sulphide, such as Poirrier's orangé. The process, in case of sulphuric acid, is as follows:—The solution of sulphate, containing preferably from 0·05 to 0·1 grm. of sulphuric acid, is placed in a capsule, mixed with from 1 to 2 vols. of strong alcohol, heated almost to a boil, and precipitated with a slight excess of neutral lead acetate. The lead sulphate then collects quickly at the bottom of the capsule. When cold, the clear supernatant liquid is poured upon a filter, the precipitate is washed by decantation with a mixture of alcohol with from ½ to 1 vol. of water, throwing the washings each time upon the filter. It is important that these liquids should only bring the smallest possible quantity of the precipitate. When the washing is completed, *i.e.*, when a drop of the filtered liquid is no longer coloured by sulphuretted hydrogen, the funnel containing the filter is placed above a clean flask and a saturated solution of sulphuretted hydrogen is poured into the filter to convert any residual traces of lead sulphate into sulphide. The mass of lead sulphate remaining in the capsule is treated in like manner with a saturated solution of sulphuretted hydrogen, and the mixture is well agitated to ensure the complete transformation of the sulphate into sulphide. Lastly, the liquid and the lead sulphide are thrown upon the filter and washed with a solution of sulphuretted hydrogen until a drop of the filtered liquid gives no reaction with Poirrier's orangé. At this moment all the sulphuric acid is found in the free state in the filtrate. It is determined with a decinormal solution of soda after the addition of Poirrier's orangé. The method is expeditious and strictly accurate, but it is applicable only in the absence of acids capable of reacting upon Poirrier's orangé, and of precipitating salts of lead. All causes which interfere with the determination of lead in the state of sulphate (presence of free nitric acid, ammoniacal salts, &c.) interfere with the accuracy of the results.

No. 2, July 20, 1888.

The Artificial Reproduction of Hydro-cerussite, the Chemical Composition of this Mineral, and the Constitution of White Lead.—L. Bourgeois.—The author's analysis of this rare mineral leads to the formula $2PbCO_3+PbO_2H_2$. It is remarked that numerous specimens of commercial white lead have a composition oscillating between the above formula and that of neutral lead carbonate. On a microscopic examination many samples, especially those obtained by the Dutch process, are found to consist of small indefinite granules. Others, prepared by precipitating neutral lead acetate with sodium carbonate, are almost entirely formed of small and very acute prisms or double pyramids of cerussite. The white lead made by the Clichy process is almost entirely crystalline, consisting chiefly of hexagonal lamellæ.

On a Hydrochlorate of Cupric Chloride.—Paul Sabatier.—The author has obtained this compound in hyacinth-red crystals, having the composition—

$$CuCl_2H_2Cl_2,5H_2O.$$

On exposure to air the crystals promptly lose their hydrochloric acid and leave green opaque needles. The red colouration of this hydrochlorate is an anomaly, since the salts of copper are blue or green. An analogous compound has been obtained with cadmium chloride.

Preparation of the Allyl Ammoniums by Means of Allyl Chloride and Aqueous Ammonia in Equimolecular Proportion.—H. Malbot.—The prolonged action in the cold of allyl chloride upon aqueous ammonia yields almost exclusively free triallylamine. In heat the same operation yields much tetrallylammonium in place of triallylamine. This difference arises from the free triallylamine combining with the available allyl chloride when the temperature becomes favourable. This instance must be joined to those previously given (*Annales de Chimie et de Physique*, April, 1888) to show the insufficiency of the simultaneous equations of Hofmann, and to demonstrate the *gradual progression* of the amines.

A Characteristic Reaction of Bismuth.—E. Leger.—The solution of bismuth iodide in potassium iodide is sometimes employed as a reagent for the detection of alkaloids, under the name of potassium iodo-bismuthate. This solution gives a fine orange-yellow deposit with a great number of organic bases; but it is a general reaction which, though very sensitive, tells us nothing concerning the nature of the alkaloid present. The author suspected that the case would be different if, instead of applying this reaction to the detection of the alkaloids, it was made to serve for the detection of bismuth. He employed to this end a reagent of the following composition:—Cinchonine, 1 part; potassium iodide, 2 parts; distilled water, 100 parts. The cinchonine is converted into nitrate, the solution is slightly heated, and the iodide of potassium is added. If this reagent is added to a solution of bismuth nitrate we obtain at once an orange yellow precipitate. The reaction is so sensitive that it shows the presence of 0·001 grm. of bismuth in a mixture of salts of copper, lead, bismuth, tin, arsenic, and antimony. It is necessary to have the reagent in excess, to avoid the presence of an excess of nitric acid. With mercuric salts the reagent gives a yellowish green precipitate, turning black if an excess of the reagent is added; with mercurous and cadmium salts a yellowish white; with silver salts an intense yellow precipitate if the reagent is in excess; with cupric salts a maroon brown precipitate; and with lead salts a sulphur yellow precipitate. This reaction cannot be used for the quantitative determination of bismuth.

MEETINGS FOR THE WEEK.

Monday, Nov. 5.—Royal Institution, 5. General Monthly Meeting.
— Society of Chemical Industry, 8. "A New Form of Polarimeter," by Mr. Heron. "Comparative Value of Antiseptics," by Mr. Kingzett.
Saturday, 10th.—Physical, 3. "On the Coefficient of Mutual Induction of a Helix and a Coaxial Circle," by Prof. J. V. Jones.

NAPHTHOL YELLOW.

NOTICE IS HEREBY GIVEN to Consumers, Dealers, and Manufacturers of "Naphthol Yellow" or "Fast Yellow" that such yellow colouring-matter is the subject of Letters Patent dated the 29th day of December, 1879, No. 5,305, which are the property of the Badische Anilin und Soda Fabrik, of Ludwigshafen on-the-Rhine and Stuttgart, Germany.

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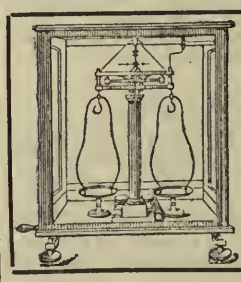

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1511.

ON THE

ACTION OF A PLATINUM WIRE MADE INCANDESCENT BY A CURRENT ON SOME GASES AND VAPOURS.

By Dr. W. R HODGKINSON, F.R.S.E., and F. K. S. LOWNDES.

Part II.

On submitting the compounds of the halogens amongst themselves to the action of the incandescent wire, previously mentioned in the case of the halogens alone, results are obtained similar to when the halogen alone is used. We find that, in the case of the halogens at least, the presence of one does not hinder the effect or action of another.

Chlorides of iodine, both ICl and ICl_3, were operated upon, the substances being formed in the flask and then vapourised to expel air, and the current then sent through the wire. A very large flame appearance was produced, and a copious deposit of platinous salt formed on the sides of the flask, a mixture of chloride and iodide, and relatively very large crystals of platinum formed on the wires, especially on one marked B. A precisely similar result was obtained by having iodine in the flask to begin with, vapourising it, then sending in a stream of chlorine.

With bromide of iodine a similar large flame was produced and mixed bromide and iodide of platinum formed, but in this case no crystals of the metal formed on the wire.

Compounds of halogens with other elements gave very different results: carbon tetrachloride showed no flame appearance, although chlorine was liberated. Carbon was deposited, and some sesquichloride formed in crystals, but no salt of platinum or metallic crystals. Phosphorus pentachloride gave a flame the first minute or so, and then evidently enough phosphorus was liberated to alloy with and cause the wire to melt.

In the case of HCl there was an evident decomposition at the temperature and under the conditions. Some $PtCl_2$ was formed, but we obtained no crystals, nor did we notice any flame appearance around either wire.

In the case of HBr there is just a little doubt that some moisture was in the bulb at the time, so the observations are not recorded here. We are repeating the experiment. It may be remarked that it is a difficult matter to dry HBr without some slight decomposition.

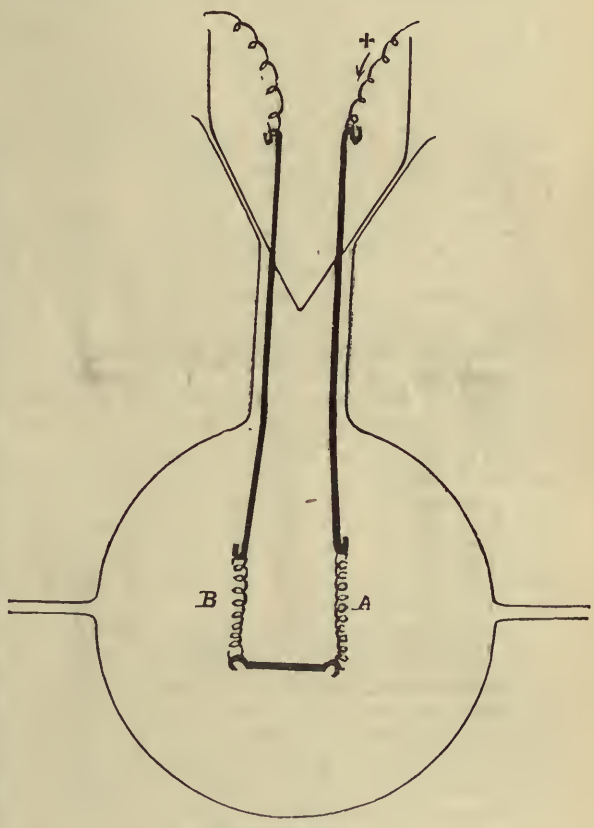
With HF there is very considerable difficulty in carrying out the experiment in a glass vessel. An experiment was made by having the bulb as dry as possible and passing a current of HF through it, but it will only be noticed here that some soluble platinum salt was formed; it will be referred to again when we describe the action on SiF_4, $TiCl_4$, BCl_3, Al_2Cl_6, and chlorides of tungsten and molybdenum. . . .

With sulphur, oxides of nitrogen, and SO_2 no apparent action took place. Phosphorus and arsenic vapours destroyed the wire at once. With mercury vapour there was no visible result. With $HgCl_2$ some platinous chloride was formed and mercury liberated, but no crystals of platinum.

The action on the platinum is evidently far more pronounced when the substances are in what is termed a loose state of combination, as with the halogen compounds amongst themselves.

With substances which do not act upon platinum no *visible* change takes place on the platinum wire. All the compounds yet tried containing halogens are decomposed by the hot wire, the liberated halogen acting then upon the cooler portions of the wire, forming a salt which must to some extent be converted into vapour, and, as this comes in contact with the hotter portions of the wire, becomes decomposed into the metal, which is deposited in crystals, and free halogen again. That something of this kind is the case is indicated by the fact that the greater portion of the crystals are formed on the hottest part of the wire; the cold portion has absolutely no metallic crystals on it. The platinous salt formed is deposited for the most part at the top of the globe above the wire: this also indicates that the salt must have been in the state of vapour; at any rate it seems to indicate that platinum salts are in the presence of the halogens to some extent volatile.

The most striking part is the lambent flame that accompanies this decomposition by the heat of the wire.



(About Half real size).

It is more than a mere glow; it moves about similar to a candle-flame, and in some cases—with ICl_3, for instance—nearly fills the flask. We do not think it can be caused by an oxidation of the halogen, for care was taken to expel all atmospheric oxygen before starting the current. That it is due to the combination of the platinum with the halogen is just possible; but in the case in which the flame appearance is greatest—iodine—there is least platinum salt formed.

As far as we can make out, also, the flame gives a continuous spectrum with dark absorption lines.

In the case of gases and vapours likely to attack cork, a flask, of the shape shown on subjoined diagram, had the neck splayed out and a tube drawn out to fit, the platinum wires being sealed through this.

We are continuing the experiments with some modifications—for instance, putting one of the coils of wire in a powerful magnetic field.

Royal Military Academy, Woolwich,
October 30, 1888.

THE CHEMICAL EXAMINATION OF CERTAIN GUMS AND RESINS.

By ROWLAND WILLIAMS, F.C.S., F.I.C.

Considering the importance of the subject, the chemical examination of gums and resins has not received the amount of attention which might have been anticipated. One of the most important contributions to our knowledge of the properties of these bodies is the research by Hirschsohn, whose results may be found in *Pharm. Zeit. f. Russland*, p. 225, 1875, and p. 1, 1877; also *Pharmaceutical Journal*, vii., 369, and viii., 389; and "Watts's Dictionary of Chemistry," viii., 1743.

Hirschsohn's work appears to have been mainly devoted to the question of the solubility of certain gums and resins in various volatile liquids, such as petroleum spirit, ether, and alcohol. The information thus obtained has undoubtedly proved useful to other chemists, more especially in connection with the analysis of varnishes.

Mills and Muter (*Journal of the Society of Chemical Industry*, iv., 96) seem to have been the first chemists to undertake a systematic quantitative examination of a number of the most frequently occurring gums and resins. Their results, however, although extremely valuable, would have been even more so if their experiments had included more than one specimen of each kind of resin. Unfortunately, with the exception of xanthorrhœa resin (8 samples) and dragon's blood (11 samples), the bromine absorptions of which were determined, Mills and Muter examined only single samples of varnish resins from a similar point of view.

Mills (*Journal of the Society of Chemical Industry*, v., 221) has also examined the action of potash on certain resins, again using single samples for his experiments. His determinationns were made by leaving weighed quantities of the finely powdered resins in stoppered bottles with excess of normal alcoholic potash, allowing to stand for eighteen hours, and titrating back with normal hydrochloric acid.

It seemed possible, therefore, that further research on a larger number of representative specimens of the different varieties of commercial gums might tend to increase our knowledge of this interesting branch of chemistry. With this object in view, a few months ago I commenced an analytical investigation of some of the more important gums. For this purpose I obtained between 40 and 50 samples from several large London firms, to whom I now beg to offer my thanks for their kindness in supplying me with the same. It unfortunately happened that I received only single specimens of some of the resins, but luckily these were, taken as a whole, of the least importance from a commercial point of view. It will be seen that in several instances at least two samples, and in the majority of cases from three to nine samples of the various kinds of resin were submitted to examination, thus allowing a wide margin for every possible difference in constitution between the varieties in question.

In these samples I determined the total potash absorption, the percentage of potash required to neutralise the "free acid," the iodine absorption, ash, and loss on drying at 212° F. The total amount of potash absorbed was found by boiling a weighed quantity of the powdered resin with an excess of semi-normal alcoholic potash for half an hour, adding a few drops of phenolphthalein solution, and titrating back with semi-normal hydrochloric acid. The acidity of the resins was determined by boiling weighed quantities of the samples with strong alcohol, and titrating with semi-normal caustic potash after addition of phenol-phthalein solution.

The iodine absorptions were ascertained in the well-known manner by means of Hübl's reagent. Ash was estimated by ignition in platinum crucibles, and loss on drying at 212° F. by exposing weighed amounts of the samples to the heat of a boiling water-bath until they ceased to lose weight.

All the estimations were performed in duplicate, and the means of the figures obtained are given in the accompanying table.

A careful examination of these results brings out many interesting features, to a few of which I should like to direct attention.

Animi.—The figures obtained from the three samples examined are, on the whole, fairly concordant—sufficiently so, at any rate, to indicate the ease with which any attempt at sophistication could be detected by an experienced analyst.

Arabic.—These three samples show a considerable difference in many respects, this being most probably due to the gums being of distinct varieties, but unfortunately I was unable to ascertain their exact commercial grades.

Again, the gum senegal differed entirely from the gum arabic.

Copal.—It will be noticed that nine samples of gum copal were examined. These may be conveniently divided into two classes—the Manilla, with saponification equivalents lying between 289 and 318, and the remaining six samples with saponification equivalents varying from 405 to 459. Omitting the last figure (which was obtained from a sample the history of which was unknown), it will be seen that the Sierra Leone, Angola, and Accra varieties have saponification equivalents lying between 405 and 435.

These remarkably constant results, in conjunction with certain other data, prove the impossibility of successfully adulterating gum copal, when this article is submitted to chemical analysis, and at the same time show the readiness with which the analyst can distinguish the different varieties of copal from each other.

Damar.—These three samples show rather wide discrepancies, but even here the saponification equivalents are so extremely high that the application of Koetstorffer's test alone is sufficient to prove the genuineness or otherwise of a specimen of damar.

Elimi.—It will be noticed that this gum has by far the highest saponification equivalent and iodine absorption of any of the samples examined, this, again, rendering any attempt at adulteration difficult, if not indeed impossible.

Kowrie.—The results obtained from the two samples agree moderately well, the slight variance between the respective figures being probably due to the difference in quality of the gums, one being termed "medium," the other "fine."

Mastic.—All the figures obtained in the case of the two specimens of mastic are remarkably close, again rendering futile any attempt at fraudulent admixture with inferior gums.

Rosins.—Perhaps the most notable feature in connection with the rosins is the increase of "free acid" in the refined samples.

Sandarac.—With reference to these samples, the main point of interest is the large amount of "free acid" present, this constituting, in fact, almost the whole of the matter acted upon by caustic potash. This point at once distinguishes sandarac from any other gum which I have examined, and is sufficient to prevent the possibility of fraud.

Shellac.—All the samples gave very similar results, the chief point of interest being that "fine orange" absorbed the smallest percentage of iodine, while "garnet" and "button" had considerably higher iodine absorptions than any of the grades of "orange."

Tragacanth.—The figures obtained were fairly con

Name of Gum.	Variety.	Percentages. Total Potash absorption.	Saponification equivalent.	Potash required to neutralise free acid.	Iodine absorbed.	Loss on drying at 212° F.	Mineral matter.
Amber	Unknown.	8·68	646	1·54	62·10	1·05	0·28
Animi	Rough Demerara.	7·36	762	2·66	127·88	0·10	0·05
	Fine Zanzibar.	7·36	762	1·82	135·25	0·48	0·11
	Unknown.	8·75	641	2·52	137·54	0·31	0·07
Arabic	Unknown.	8·40	668	0·84	0·51	8·13	0·22
	,,	5·67	989	0·28	None	11·32	2·45
	,,	8·97	625	0·22	None	12·44	2·29
Asphaltum	Syrian.	2·37	2367	0·89	54·08	2·24	6·55
Benzoin	Unknown.	14·84	378	9·80	76·45	4·66	1·32
Bone Pitch	Unknown.	2·50	2244	2·39	66·04	0·44	0·36
Copal	Soft Manilla.	18·41	305	13·16	137·79	0·79	0·21
	Borneo ,,	17·67	318	14·14	138·04	2·24	0·08
	Singapore ,,	19·41	289	12 88	123·31	2·41	2·06
	Cleaned Sierra Leone.	12·90	435	8·40	138·04	0·91	0·07
	Rough ,, ,,	13·85	405	7·28	133·35	1·04	0·07
	Rough Accra.	13·16	426	4·62	121·66	1·48	1·03
	Rough white Angola.	13·30	422	5·74	129·66	0·57	0·27
	Fine clean red ,,	13·62	412	6·02	136·90	0·40	0·02
	Unknown.	12·22	459	5·74	142·24	0·98	trace
Damar	Batavia.	3·64	1541	2·24	117·67	0·33	0·01
	Unknown.	3·11	1804	2·66	142·24	0·85	0·07
	,,	4·07	1378	2·10	130·24	0·71	0·03
Dragon's Blood ..	Unknown.	15·34	366	1·12	98·42	9·34	3·58
Elimi	Unknown.	2·86	1962	1·57	175·39	3·50	0·04
Gamboge	Unknown.	14·78	379	8·06	115·82	3·70	0·48
Kourie	Medium.	9·93	565	6·30	151·13	4·63	0·12
	Fine.	7·74	725	5·18	164·21	3·69	0·08
Mastic	Unknown.	7·34	764	5·04	158·62	0·97	0·20
	,,	7·91	709	5·60	159·00	1·46	0·14
Rosin	Refined, 1st Sample.	18·74	298	17·92	115·31	0·13	0·05
	,, 2nd ,,	19·57	286	17·78	114·80	0·14	0·02
	Ordinary 1st ,,	17·64	318	16·94	112·01	0·32	0·08
	,, 2nd ,,	19·01	294	16·66	113·28	0·34	1·20
Sandarac	Unknown.	15·54	361	15·40	*	1·88	0·04
	,,	15·70	357	14·56	134·30	1·44	0·17
Senegal	Unknown.	10·42	538	0·28	5·59	23·70	2·59
Shellac	Medium Button.	20 33	276	6·30	24·62	1·06	0·28
	Garnet.	21·26	263	5·60	28·70	0·72	0·37
	Fine Orange.	20·64	271	6·44	17·52	1·23	0·31
	Good 2nd Orange.	21·07	266	4·76	20·40	0·88	0·42
	Fair 2nd ,,	21·14	265	5·60	19·81	1·01	0·63
	Inferior 2nd ,,	19·41	289	5·74	19·05	1·41	0·94
Tragacanth . ..	Unknown.	11·05	508	0·14	None	16·86	2·64
	,,	11·98	468	0·14	1·16	13·52	2·69

* Owing to an accident ther was not enough of this sample left for the iodine absorption test.

cordant, the greatest discrepancy being in the percentage of water, the proportion of which is known to vary in different samples to a moderate extent.

The preceding figures will, no doubt, be of considerable service to those who may at any time be called upon to examine the gums and resins of commerce in their ordinary conditions, and also, I trust, to chemists engaged in the tedious and oftentimes most difficult analyses of varnishes made therefrom.

In conclusion, it gives me great pleasure to express my thanks to two of my pupils—H. Winstanley and C. Boothby—for their able assistance during the progress of this investigation.

28, Pall Mall, Manchester
November 1, 1888.

THE ESTIMATION OF QUININE BY KERNER'S METHOD.

By EDSEL A. RUDDIMAN.

(Concluded from p. 218).

(5) *On the Amount of Water which should be used in the Application of Kerner's Test to Salts of Quinine other than the Sulphate.*—Dr. Prescott* called my attention to the fact that, in the U.S. Ph., application of Kerner's test to the salts of quinine other than the sulphate, the proportion of ten parts of water to one part of *the sulphate formed* is not retained. By thus varying the proportion of water, the stringency of the test is subjected to variation. Following, are equations showing the amount of water which should be used if the proportion in the original test of Kerner be preserved. Dr. Lyons has also called my attention to the fact that in the U.S. Ph. test for quinine sulphate itself, the original proportions are departed from, inasmuch as the weighed amount of the crystallised salt is dried before treatment with the water. Therefore the proportions of water calculated below must be multiplied by the factor 0·878 to bring them to the proportions of the U.S. Ph. test for the sulphate. The factor 0·878 is based upon the averages of Henry B. Parsons in 1884, giving 13·84 per cent water as the mean quantity in 1015 samples from 100 ounce cans just opened.

For the Free Alkaloid.

$$\underbrace{2C_{20}H_{24}N_2O_2,\ 3H_2O}_{756}+(NH_4)_2SO_4+\underbrace{7H_2O}_{126}=\underbrace{(C_{20}H_{24}N_2O_2)_2H_2SO_47H_2O}_{872}+2NH_3+6H_2O.$$

756 : 872 :: 1 : × = 1·1534 1·1534 × 10 = 11·534

756 : 126 :: 1 : × = 0·166 (after evaporation on water-bath, and then adding water, $7H_2O$ taken up).

11·534 + 0·166 = 11·700 11·7 c.c. of water to be added to 1 grm. of the alkaloid.

Hydrobromide.

$$\underbrace{2C_{20}H_{24}N_2O_2HBrH_2O}_{845\cdot6}\dagger+Na_2SO_410H_2O=\underbrace{(C_{20}H_{24}N_2O_2)_2H_2SO_47H_2O}_{872}+2NaBr+\underbrace{5H_2O}_{90}.$$

845·6 : 872 :: 1 : × = 1·0312 1·0312 × 10 = 10·312

845·6 : 90 :: 1 : × = 0·106 (correction for water of crystallisation).

10·312 − 0·106 = 10·206 c.c. of water to be added to 1 grm. of hydrobromide.

15·309 c.c. of water to be added to 1½ grm. of hydrobromide.

Hydrochloride.‡

$$\underbrace{2C_{20}H_{24}N_2O_2HCl2H_2O}_{788\cdot8}+Na_2SO_410H_2O=\underbrace{(C_{20}H_{24}N_2O_2)_2H_2SO_37H_2O}_{872}+2NaCl+\underbrace{7H_2O}_{126}.$$

788·8 : 872 :: 1 : × = 1·1054 1·1054 × 10 = 11·054

788·8 : 126 :: 1 : × = 0·159 (water of crystallisation).

11·054 − 0·159 = 10·895 c.c. of water to be added to 1 grm. of hydrochloride.

16·342 c.c. of water to be added to 1½ grm. of hydrochloride.

Bisulphate.

$$\underbrace{2(C_{20}H_{24}N_2O_2)H_2SO_47H_2O}_{1096}+2NH_4O+\underbrace{7H_2OH}_{126}=\underbrace{(C_{20}H_{24}N_2O_2)_2H_2SO_47H_2O}_{872}.$$

1096 : 872 :: 1 : × = 0·7956 0·7956 × 10 = 7·956

$(NH_4)_2SO_4+16H_2O$.

1096 : 126 :: 1 : × = 0·114 (water of crystallisation).

7·956 + 1·114 = 3·07 c.c. of water to be added to 1 grm. of bisulphate.

The U.S. Ph. test of the free alkaloid is more stringent than for the sulphate, since it directs that for every 10 c.c. of water there shall be sufficient alkaloid used to make 1·1534 grm. of the sulphate. In case of the hydrochloride or the hydrobromide, the test is considerably more severe, first, because an insufficient amount of water is used, and second, because in the conversion of the hydrochloride or hydrobromide into the sulphate, direction is made to use hot water. In testing the bisulphate the officinal method directs that, to the mixture of the salt and water ammonia be added to neutralisation, and then sufficient water added to make the mixture measure 10 c.c. This is to be criticised for two reasons: first, because it does not take into account the fact that 1 grm. of the bisulphate forms only 0·7956 grm. of the normal sulphate, and second, because there is no allowance made for the space occupied by the salt, and the proportion of water added to the sulphate formed varies inversely with the volume of the salt. To 1 grm. of the bisulphate of quinine as tested in the U.S. Ph. there should be added in all (taking into consideration the water of ammonia) 8·07 c.c. of water.

In applying the U.S. Ph. tests to the salts of quinine other than the sulphate, some difficulty* has been experienced in obtaining the required 5 c.c. filtrate. Various methods have been offered to obviate the difficulty, but the one proposed by C. N. Lake† seems to be the one which the most nearly corresponds to the original test. It is to increase both the amount of salt and of water yet preserving the proportion between them. Working with the free alkaloid I found in using the ratio of water to the alkaloid as directed in the officinal test, by taking 1½ times as much as there stated, the required 5 c.c. filtrate could be obtained with a little difficulty, but doubling the amount no difficulty was experienced. By taking 1½ grms. of the alkaloid and 17·5 c.c. of water, which is in the proportion of 10 parts of water to 1 part of the sulphate formed, the 5 c.c. of filtrate can be easily obtained. With the hydrochloride and hydrobromide I had no difficulty by taking the amount of the salt and water as directed in the pharmacopœia. Since the amount of water which *should* be used is greater than the amount which *is* used, there was of course no difficulty when the correct amount was taken. In case of the bisulphate the required amount of filtrate may be obtained either by doubling the amounts directed in the pharmacopœia or by taking 2½ grms. of the salt and the theoretical amount of water, which is 20·09 c.c.

Conclusions.—(1) The pharmacopœial test of commercial quinine sulphate when applied as there directed does not, as a rule, correctly indicate the amount of cinchonidine sulphate present. By using a higher temperature and water sufficient to dissolve all of the salt, a closer approximation to the real amount of cinchonidine contained therein may be obtained.

(2) The temperature of the resulting liquid at the time the titration is completed has a considerable effect upon the amount of ammonia water necessary to re-dissolve the precipitate. For every degree that the temperature of the titration is above 15°, there should be added 0·148

* 1887; *Organic Analysis*.

† The authority for giving the hydrobromide of quinine as having but one molecule of water of crystallisation is found in the "French Codex, p. 148, and in "Ladenburg's Handwörterbuch, i., 250.

‡ On Kerner's volumetric method as applied to the hydrochloride. *Archiv. der Pharm.* [3], xix., 1. *Jahresb. der Pharm.*, 1881—2, p. 662.

* 1885; *Contrib. Dep. Pharm. Univ. Wisc.*, 1885, ii., 17. *Proc. Am. Pharm. Assoc.*, 1886, xxxiv., 601.

† 1885; *Drug. Circular.*, xxix., 199.

c.c. to the number of c.c. of ammonia water of sp. gr. 0·920 used.

(3) In my experiments I found that 0·36 c.c. of water of ammonia, sp. gr. 0·920, is necessary to precipitate and re-dissolve 1 m.grm. of cinchonidine sulphate, *i.e.*, in the quantitative estimation of cinchonidine sulphate in quinine sulphate, every 0·36 c.c. of ammonia used in titrating the 10 c.c. of filtrate from the sample being tested over that used in titrating the 10 c.c. of filtrate from the standard quinine, indicates 1 m.grm. of cinchonidine sulphate in 1 grm. of the sulphate of quinine tested, or 0·1 per cent.

(4) In estimating the cinchonidine sulphate in commercial quinine sulphate to get a result nearest correct, it is necessary to dissolve the salt. This can be done by using a temperature of 100° C. and 30 parts of water; if more water be used the temperature need not be so high, but while the amount of impurities remains about as found at present, 30 parts of water will be sufficient.

(5) The proportion of water to the sulphate in the officinal test of the forms of quinine is not precisely the same as in Kerner's original test. If the proportion in the latter case be retained, there should be used for 1 part of the free alkaloid 11·7 parts of water; for the bisulphate, 8·07 parts of water; for the hydrochloride, 10·895 parts of water; and for the hydrobromide, 10·2 parts of water. Also for the dried sulphate 10·144 parts of water.—*Journal of Analytical Chemistry.*

AN INQUIRY INTO THE RELATIVE VALUE OF ALUMINIUM AND ITS ALLOYS TO THE ARTS.*

By H. PEMBERTON, Jun.

Of late years a considerable amount of attention has been paid to the metal aluminium. Much has been written about it; many plans have been proposed for its extraction, and numberless patents, embodying these plans, taken out, both in the United States and abroad. In fact, the subject appears to possess a species of fascination, as it has attracted attention from all directions. Parties supplying the raw materials or chemicals used in the experiments report that the demand for such comes not only from chemists and metallurgists, but also from business men, lawyers, and professional men of all kinds. The long list of foreign patents on the subject shows how widely it attracts interest. Prof. Richards's treatise on aluminium contains fifty-four pages—one-sixth of the entire book—on the manufacture of the metal by processes other than the regular one of Deville.

There is no difficulty in giving an explanation of this. Of all the metals, properly so called, the compounds of which make up the crust of the earth, aluminium is the most abundant. This statement is literally true; there is no exception to it. It is evident, therefore, that there can be no difficulty in obtaining material to work upon. Now, taking ordinary clay as an instance, it can be readily shown that in every cubic yard there is at least 800 pounds of aluminium, the lowest recorded price of which is five dollars a pound. Clay can be had, in many cases, at a cost not exceeding that of digging it out. The apparent profit can readily be calculated.

The practical outcome, however, of all this work, and of all these experiments, is that the only process by which any quantity worth speaking about of the pure metal aluminium—in contradistinction to its alloys—has ever been extracted, is the process of Deville, established about a third of a century ago. Modifications in the preparation of the materials have, indeed, been made. But the main features of the process, and the sequence of operations, have remained unchanged. The large aluminium works now just about starting, near Birmingham, England, employ the same chemicals, and rely upon the same reactions that the French chemist did in the fifties.

This company—the Aluminium Company, Limited—has gone into the manufacture on a scale never heretofore approached. According to the descriptions in a number of English technical journals, the works comprise a plant of twenty furnaces for the manufacture of metallic sodium by the Castner process, with a total capacity of about 1500 pounds a day; a set of twelve regenerative heating furnaces, containing sixty retorts for the manufacture of the double chloride of aluminium and sodium, turning out about 5000 pounds every twenty-four hours; a Weldon chlorine plant; and furnaces for reducing the aluminium from the double chloride by means of the sodium. The total capacity of the works is about 500 pounds of aluminium daily. According to the Chemical News, (vol. lviii., p. 65) the production of the entire world has heretofore not been over fifty pounds a day. It appears, therefore, that the new company can manufacture in five or six weeks as much as has hitherto been produced in a year. The selling price of the aluminium has been placed at about five dollars a pound as against eleven dollars, lately. The reduction is due partly to the large scale of manufacture, but principally to the cheapening of the cost of the sodium by Mr. Castner's process. It is to be noted that the aluminium made by this company will be in the form of the pure metal unalloyed. If it is desired to produce alloys, they can only be made, or, at any rate, they have only been made, by first manufacturing the metal and then alloying it.

Exactly opposite is the case with the Cowles electric smelting process. Here the aluminium has always been produced as an alloy, with either copper or iron. The manufacture of the pure metal on a commercial scale does not appear to have been successful so far, and it is probable that the large demand for the alloys has prevented proper attention being given to this branch of the subject. There is no inherent reason why the metal itself should not be produced, but as a matter of fact, up to this date, such has not been the case.

There is one point connected with this process which is worth drawing attention to; that of the reduction of aluminium from its oxide in the presence of carbon, at a high heat. The discovery of this property of the element was as radical and as unexpected as the discovery of a new oxide would have been. All previous efforts to accomplish this had been utterly fruitless, so much so that the hope of so doing had been almost entirely abandoned. Only a few years before the Messrs. Cowles took out their patents, the late Mr. Walter Weldon asserted that it would be about as sensible to try to get five from two times two as to reduce alumina by carbon. "Never prophesy unless you know," said Artemus Ward. This property of the metal is worth drawing attention to, as the practical results of the new process appear to have overshadowed a discovery very interesting from a scientific point of view.

The electro-smelting process appears to have been making great advances of late. A description of it was embodied in a "Report of the Committee of Science and the Arts of the Franklin Institute" (*Journal of the Franklin Institute*, July, 1886). Since this report was published several improvements have been made. It has been found practicable to tap the furnace, and allow the molten metal to flow directly into the ladle or into slabs, instead of letting it cool in the furnace and then putting it cold into crucibles to be re-melted. This has practically doubled the capacity of the plant. Another improvement has been in the use of bauxite, as well as corundum, for a raw material, thus ensuring an abundant supply of alumina. The works at Lockport, N.Y., have now two dynamos of 217 electric horse-power each, driven by water-power. The new establishment at Milton, England, has a 402 E. H. P. machine, put up experimentally and

* Read before the Franklin Institute, September 19, 1888.

to be followed by others. Both of these works are reported to be running day and night.

It appears, then, that the aluminium industry has at length attained a firm footing and is well established. The two lines of manufacture differ essentially in their characteristics. One is a chemical process, the other a metallurgical. One produces the pure metal only, the other only its alloys. One is a complicated process, the other a simple one. Indeed, the Cowles process is extremely simple, consisting, as it does, of only the dynamo, with the power to drive it, and the application of its current to the mixture of carbon, alumina, and the metal to be alloyed. Compared with this, the Deville process is a very elaborate one. Compared with any process, it is a very elaborate one. Indeed, it is doubtful if in the whole field of chemistry and metallurgy together there can be found any process which involves such an intricate series of operations as this one does. There is a department for preparing the alumina, a department for preparing the iron and carbon compound (Castner's patent), another for manafacturing the metallic sodium, another for re-working two-thirds of the sodium remaining as carbonate from imperfect reduction. (This, indeed, is done in an adjacent works, but has to be paid for, of course, just the same). There is a department for manufacturing chlorine by the Weldon process; another for mixing the alumina, carbon, and salt, moulding and drying the same; another for treating this mixture with chlorine at a red heat for the production of the double chloride of aluminium and sodium, and finally, one for treating the double chloride with sodium by which the alumina is reduced to metal. The manufacture of some high-priced organic compound—for instance, Fahlberg's saccharin—may approach this, but it is doubtful if it exceeds it. The Solvay process of manufacturing soda-ash has often been cited as one having had a long up-hill fight. But the Solvay process had the additional struggle of having to manufacture its product for less than two cents a pound, or else not at all, whereas metallic aluminium is sold for twice as many dollars a pound. It needs no expert to see that the cost of the aluminium in alloys, as made by the electro-smelting process, must necessarily be only a fraction of that of the metal made by the Deville. It follows, therefore, that the latter process will not be likely ever to compete with the former in the manufacture of alloys, but will have as its legitimate field the production of the pure metal. It is dangerous to assert a negative. But it is hard to see how there can be any escape from the above deduction. Perhaps a possible exception may be named in the case of certain alloys of aluminium and silver—such as *tiers argent* and a few others of like kind, used in table-ware.

There are three properties, or characteristics of aluminium that make it valuable in the arts. It is a light metal (sp. gr. 2·56), being about one-third as heavy as iron. It is a pretty metal, and not very readily acted upon by atmospheric influences. In this respect it rivals silver, which is blackened by sulphuretted hydrogen, by which aluminium is not affected. Upon exposure for some time, however, or by handling, the surface loses its brilliancy and becomes, through oxidation, more or less "dead," resembling tin or zinc, though superior to them, as the colour is much whiter. In the third place, it is a fairly strong metal, about equal to brass. It is destined to play a valuable rôle in the manufacture of philosophical instruments. Prominent manufacturers state that the weight of theodolites, levels, compasses, sextants, &c., is about one-third less when made of it, and seem to think that there is no doubt of its being largely employed at the quoted English price. All the bearings and wearing surfaces of these instruments must still be made of brass, as aluminium is not hard enough. It is coming into use for making beams of chemical balances with a capacity up to as much as 200 grms., and has long been used for the smaller weights. The moulds for casting such beams are the same as have been used for the ordinary bronze. Opera and field-glasses, when made of it, are much lighter and can be used with great ease and comfort. It cannot be employed for cooking utensils, as it dissolves easily in organic acids in the presence of chlorides, such as common salt (Roscoe). A few other uses in which the pure metal appears to advantage are aluminium leaf, fine wire lace, certain surgical instruments, suture wire, dental plates, &c. Aluminium jewellery has failed to make any headway; it tarnishes too easily and becomes brittle.

It will be observed that nearly all of the above uses are for objects small in size. Many suggestions have been made for its use on the larger scale, as in aërial navigation, or for engineering and constructive purposes. Some of these are of a very sensational nature, as for example:—

"The dead weight of trains could be saved by constructing freight and passenger cars of aluminium. . . . Ships larger than the *Great Eastern*, with less draught, could be constructed nearly entirely of aluminium, including the machinery and boilers which at present weigh down vessels seriously. . . . Railway beds, sleepers, ties, rails, bridges, and all, will be cast solidly in their places, with airy aluminium palace cars dancing over them 100 miles an hour or more," &c.

There is a fallacy involved in all such writing which may be worth showing up. The writer's attention is pre-eminently attracted by the low specific gravity of the metal. When employed in any construction where it will be required to withstand severe stress, the metal with which it will immediately come into rivalry will be steel. The specific gravity of steel is almost exactly three times that of aluminium. Of course an inch rod of the latter metal will therefore weigh only one-third as much as an inch rod of steel. But when we examine the tensile strength of the two we find that steel has three times the strength of aluminium. It follows, therefore, that to make the aluminium rod of the same strength as the steel, it must be three times the size. The two rods will now weigh exactly the same. Where, then, is the advantage of the low specific gravity of the aluminium?

The extraordinary qualities of many of the aluminium alloys have long been known. The bronze is the strongest of cast metals, and, when rolled, the strongest of rolled metals. Nor does it corrode as ordinary bronze does, and its fine golden colour gives it a very pleasing appearance. Aluminium brass is noted for its great strength, for its extraordinarily high elastic limit, and for its cheapness. Being composed of equal weights of zinc, copper, and 10 per cent aluminium bronze, it contains only $3\frac{1}{3}$ per cent of aluminium; hence its lower price.

Aluminium iron is now extensively used in the production of wrought-iron castings (Mitis castings). That the fusing-point of wrought iron should be reduced almost 500° by the addition of only 1-1000th of its weight of aluminium, is another instance of the wonderful properties of this extraordinary metal. The effect of its addition to cast iron is shown in a paper on this subject by W. J. Keep (*Journal of the Franklin Institute*, cxxvi., p. 220). Large quantities are now being used also with steel, a very minute amount ensuring the solidity of the castings. Indeed it appears that aluminium will be used almost universally in the metallurgy of steel and of iron, including puddled iron. Its strength-giving properties are extraordinary. There is hardly any metal with which it will not alloy; and it alloys with nothing that it does not improve. It would be only tedious to attempt to describe its endless applications. Two of the most important, however, may be noticed. The bronze is destined to play an important part in the manufacture of cannons. The war that is waging between experts, regarding the relative value of cast and of built-up guns, is so fierce that it appears difficult to obtain a discussion on the subject that does not involve the introduction of this pet fight. Aluminium bronze can, of course, be used for either type, although the cast gun is naturally much the cheaper. Such cannon could be made to possess

almost any desired combination of properties, from 114,000 lbs. tensile strength and 5 per cent elongation to 90,000 lbs. and 10 per cent, and to 72,000 lbs. and 47 per cent. The castings would be free from blow holes, could be poured at a comparatively low temperature, would be free from any separation of the ingredients or liquation, and would therefore be of uniform composition throughout. The plant required to construct them would be simple compared to the elaborate establishments necessary in the construction of the steel guns of the built-up type. Unlike these latter, the bronze gun when worn out could be melted up and cast over again, as the value of the metal in them is about two-thirds that of a new gun. Aluminium bronze stands this treatment on account of the above-mentioned freedom from liquation.

Aluminium brass is now being used by the United States Government for the manufacture of propeller blades for the new war vessels. Various metals have been used for this purpose. Cast-iron is too weak. Steel has some admirable qualities, but is very liable to corrosion, the average life of a steel blade being only four years. Ordinary bronze has been used, but is deficient in strength. Manganese bronze has, until lately, headed the list. Our Government, therefore, ordered the propellers to be made of this metal. Attention, however, was drawn to aluminium brass, and numerous comparative tests were therefore made, with the following results :*—

	Mang. Bronze.	Al. Brass.
Tensile strength per sq. inch, tons..	29—31	34—50
Transverse „ „ „ cwts..	28—52	75—85
Price per ton in ingots	£112	£103

The order for manganese bronze was accordingly countermanded, and aluminium brass adopted in its stead.

It is difficult to speak of these alloys without appearing to be guilty of extravagance ; their quality is so uniformly excellent, their appearance so fine, their uses so many. But hundreds and hundreds of tests, similar to those above given, have been made, both officially and in private, and the results obtained have invariably substantiated all that was claimed for them. The chemical process at Birmingham also has a wide future before it. It can hardly be said to have more than started as yet, and the introduction of its "silver from clay" will naturally require time. Much is owing to chemistry for what it has done in the extraction of this elusive metal. But it cannot be denied that the value of aluminium in the arts will be chiefly in its alloys, and that the greater debt of gratitude is due to that protean and subtle form of motion known as electricity.

VOLUMETRIC DETERMINATION OF CHLORINE.

By JOHN TSAWOO WHITE.

Some time ago I proposed a method for the determination of bromine in a mixture of bromides, chlorides, and iodides. I will now propose a method for determining chlorine in a mixture of soluble haloid salts, the bromide, if any, being previously separated by boiling with aluminium sulphate and potassium permanganate. Before I stumbled on the reaction of potassium bromide with $KMnO_4$ and $Al_2(SO_4)_3$, I thought of attempting to determine quantitatively the amount of the halogens in mixtures containing them. Looking up previous work that had been done I came across Edward Hart's proposal for the qualitative detection of chlorine, bromine, and iodine in a mixture by using ferric sulphate and potassium permanganate. Not having the iron salt, I used aluminium sulphate as a trial, knowing that iodine would not come off, but with no expectation that bromine would be evolved, and I got a perfect separation of bromine from chlorine and iodine. The chloride is left unchanged, as the whole of the chlorine may afterwards be obtained by distillation; and the iodide, as is well known, is converted into iodate.

The following apparatus served for the distillations. A flask with a side tube of about 100 c.c. capacity contains the liquid to be distilled ; through the rubber cork passes a tube reaching almost to the bottom of the flask for conducting carbon dioxide ; the exit tube is connected by rubber tubing with a bent tube dipping into a solution of potassium iodide contained in a test-tube, which is placed in a beaker containing cold water. The indiarubber stopper is slightly acted on by chlorine and bromine, but this cannot be avoided. And there is the danger of mechanical spirting of the potassium iodide solution with a current of gas passing through it ; the current was, however, kept moderate. A Will and Varrentrapp's bulb or some other absorption tube might have been used.

The reaction of hydrochloric and permanganic acids to produce chlorine is well known. But the formation varies with the degree of dilution and the amount of permanganic acid. To get all the chlorine in the free state from a given amount of chloride was my object. The following method was adopted. The solution is mixed with 1 grm. potassium permanganate and 5 c.c. of dilute H_2SO_4 of equal volumes of the strong acid and water, the total volume being 50 c.c. This is gently heated in a current of carbon dioxide, the liberated chlorine being absorbed by a solution of potassium iodide. Active ebullition is not necessary, and the condensing steam will heat the iodide solution. Fifteen minutes' heating may be considered sufficient. To be certain it may be again heated for another quarter of an hour, using fresh iodide solution. If the iodine liberated then is discoloured by a drop of decinormal thiosulphate it may be disregarded, for on heating a solution consecutively three times for a quarter of an hour each time with fresh iodide solution, a trace of iodine was always liberated, and the blue solution was decolourised by a drop of N/10 $Na_2S_2O_3$, a quantity representing less than 0·0002 Cl. With the above quantities of permanganate and sulphuric acid, 0·100 Cl may be distilled. The following are the results obtained by the method, the amount taken being determined by a silver solution, and the liberated iodine titrated by N/10 $Na_2S_2O_3$, standardised with $K_2Cr_2O_7$.

Taken.	Found.
0·0026 Cl	0·0030 Cl
0·0131 Cl	0·0140 Cl
0·0524 Cl	0·0539 Cl
0·0026 Cl+0·0082 Br	0·0035 Cl+0·0083 Br
0·0262 Cl+0·0421 Br	0·0274 Cl+0·0429 Br
0·0262 Cl	0·0267 Cl
0·0131 Cl	0·0129 Cl

The experiments are given in the order that they were tried. In trying the last three experiments the carbon dioxide obtained from marble and hydrochloric acid was passed through a solution of sodium dicarbonate to free it from traces of acid vapour ; I did not think of it till the results always came too high.

In trying mixtures with a bromide the bromine was first liberated. To the residue, whose volume was about 50 c.c., 1 grm. of $KMnO_4$ and 5 c.c. of dilute H_2SO_4 (1 part of acid, by volume, to 1 part of water) are added, and the distillation continued. The aluminium sulphate used must contain no chlorine, or the amount must be known. 5 c.c. of my solution contains 0·0006 Cl, and this amount was subtracted from the quantity obtained when it was used.

Before the adoption of the above method experiments were tried to see at what rate the chlorine was evolved. The chlorine in dilute solutions is difficult to distil, but it comes off entirely, if heated long enough, in the free state and not as hydrochloric acid.

Compared to the formation of chlorine, the liberation of bromine by $Al_2(SO_4)_3$ and $KMnO_4$ acting on bromides is

* See *Engineering*, London, April to June, 1888.

very easy. The bromide is decomposed at the ordinary temperature here of about 30° C., as is shown by the liberation of iodine by passing carbon dioxide through the mixture; so that it may be possible to obtain all the bromine if the current of gas is continued sufficiently long.

And the iodine of an iodide may be distilled from mixtures with chlorides and bromides by ferric chloride, chromic acid, and hydrogen dioxide.

Thus in a fair way is realised the solution to the question of directly determining bromine, chlorine, and iodine quantitatively in a mixture of the haloid salts by methods purely volumetrical.

Rangoon College, October 11, 1888.

THE AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Chemical Section.

As we have already intimated the New South Wales papers, in the exercise of their indiscretion, have allotted but a very scanty space to the proceedings in this Section.

Thus of the Presidential Address delivered by Prof. Black, D.Sc., we find it merely reported that the speaker discussed chemistry in reference to education. He argued that chemical training should be given in all schools, especially in those of higher grade. In this respect there was room for a great improvement.

Mr. C. A. Smith, F.I.C., F.C.S., read a paper on "Butterine" as an article of food. He explained that this article, which he should preferably have named Margarine, was first made in Holland, about 1869, by one Nierge, and that at first it was sold as butter. He recommends its use as a fuel-food, it being made of carefully prepared dripping, churned up with milk, and coloured to imitate butter. He then described the margarine factory at Waterloo (probably near Melbourne), where the output is about 3 tons weekly, most of which is exported to Java, Mauritius, and the Cape.

Mr. W. A. Dixson gave a paper on the "Formation of Coal." The examination of some coal from New Zealand and the other colonies had led him to the conclusion that the chief differences in coal were due to the original nature of the vegetable matter of which they were composed. The best ligno-cellulose was originally composed of resins, and Cannel coal appeared to be derived from adipo-cellulose mixed with ligno-cellulose.

The Secretary, Mr. Hamlett, read a paper, by Mr. F. Ratte, on "Means of Popularising the Study of Crystallography,"—certainly a difficult undertaking.

Mr. J. H. Mingaye, F.C.S. (Analyst and Assayer to the Department of Mines), read a paper on the "Discovery of Tellurium in certain Bismuth Ores, found near Captains' Flat, in New South Wales." The physical characteristics of the minerals had been described by T. W. E. David, B.A., F.G.S., Geological Surveyor to the Department of Mines.

Mr. Pond announced the fact that he had found tellurium in 1885 in New Zealand in some silver ores to which his attention had been called by Sir James Hector.

Mr. Hamlett read a paper sent in by Mr. Edgar Hall, F.C.S., of the Sunny Corner Silver Mine, on "Silver Smelting, Rich Silver Mattes, and their Treatment, and on Kernel Roasting." He showed that the main object of the smelter was to get clean slags. He did not consider that the dissemination of matte globules satisfactorily explained the losses of silver, as he had detached perfectly pure crystals from the very heart of the pot from slags of every kind, which yet often contained more silver than the main body of the slags. He thought that "high" silver slags might be due to the property possessed by silver of passing from already solidified portions of a body in which it is present into any portions which still remain liquid. The difficulties found in smelting certain classes of silver ores were next described, and remedial measures were proposed. The paper closed with an account of the process known as "kernel roasting."

In the discussion which followed Mr. Pond observed that if the Section had done nothing more than produce this one paper it had done valuable work.

Professor Liversidge furnished Notes on the projected Chemical Laboratory for the University of Sydney, with plans and diagrams of the apparatus to be erected. The new buildings will be 150 feet by 84 feet, and will include a main laboratory 72 by 36 feet, affording room for 130 students engaged in practical work. We shall be happy to learn that the facilities thus to be created are fully ultilised.

Two important papers read are not reported: one by Mr. W. Skey on "Gold—its Formation in our Reefs, with Notes of Some of its Newly-discovered Reactions." Mr. Don also read a paper on the question "How Gold came into the Reefs."

Two further papers, namely, by Mr. J. H. Maiden on the "Chemistry of Indigenous Australian Products," and by Mr. W. M. Hamlett on the "Action of the Nepean Water on Tubes and Boiler Plates," were taken as read.

We the more regret the insufficient manner in which the proceedings of the Chemical Section are reported, because it does not appear certain whether and when the Transactions of the Sydney Meeting will be published in full. At least the question of ways and means seems by no means fully decided.

OBITUARY.

PROFESSOR TUSON.

We regret to announce the death, at the premature age of fifty-six, of Prof. Richard Vine Tuson, who for the last twenty-eight years has held the post of Professor of Chemistry in the Royal Veterinary College, London.

Prof. Tuson began his scientific training under Prof. Graham, at University College, and was afterwards Assistant successively to Prof. Ronalds, in Galway, and Dr. Stenhouse, at St. Bartholomew's Hospital, in London. He was afterwards elected Lecturer on Chemistry to the Medical School of Charing Cross Hospital, where he was universally popular with students and teachers. A few years later he tried for and obtained the Professorship which he held until his death, which took place, in his house at Erith, on the 31st of October, 1888.

Prof. Tuson was a thorough chemist and an able teacher and experimenter. Various scientific papers stand in his name, but his most important literary labour was the new edition of Cooley's well-known "Dictionary of Receipts," which he prepared with care and skill. He was a good and most amiable man, and his untimely death, from heart disease,—which it appears had been making unsuspected progress in his system for years,—will be lamented by a wide circle of friends.

NOTICES OF BOOKS.

Chemical Notes and Equations, for the Use of Students. By R. Milne Murray, M.B., F.R.C.P.E. Third Edition. Edinburgh: McLachlan and Stewart. London: Baillière, Tindall, and Cox.

The author of this work says, in a note prefixed to his first edition (1879), that his "Notes" are not ntended to take the place of a systematic text-book or of lecture-notes; they are to afford to the junior student a means of ready reference. To that unfortunate and ubiquitous

personage "the student preparing for examinations" they are recommended as a means for "refreshing his memory on the chief facts of inorganic chemistry."

In a note to the present edition mention is made of two revisions. Nevertheless a third such operation would not be entirely out of place. Thus on p. 2 we find a mixture described as "a substance formed of two or more parts which are separable by mechanical means." As an example is given the atmosphere, a mixture of oxygen and nitrogen. But when we require to separate these two gases we are obliged, as the author must be perfectly aware, to employ the purely chemical means of causing the oxygen to enter into a non-gaseous combination.

We can scarcely admit the author's view that "abase is always an oxide," since a few pages further on he speaks of the well-known sulphur bases.

In the table of atomic weights that of platinum is still given as 197·5, instead of the more correct value 194·8.

On p. 56 the student is told that fluorine has not been got in the free state, a statement which is decidedly out of date.

Red phosphorus, it is said, is "not combustible,"—an evident exaggeration.

The above-mentioned points, and a few others which the reader will not fail to discover, stand in need of rectification.

Les Théories et les Notations de la Chimie Moderne (The Theories and Notations of Modern Chemistry). By Antoine de Saporta, with an Introduction by C. Friedel. Paris: J. B. Bailliere et Fils.

This book belongs to a series entitled "Bibliotheque Scientifique Contemporaire," which is by no means exclusively confined to scientific subjects.

M. de Saporta, in the volume before us, undertakes to lead his countrymen to the same point of view in chemical science which has been definitely adopted in every civilised country save France alone. M. Friedel, in his excellent Introduction, admits that "by a singularity which is not unexampled in the history of French science and industrial art,—we may instance the reception accorded beyond the Channel to the doctrine of organic evolution,—a theory the first foundations of which are of national origin finds the greatest difficulty in taking root among us."

How little M. de Saporta is swayed by French convention appears from the fact that, as a symbol for nitrogen, he recommends N in preference to Az.

Again, he recognises that the term "metalloids," so frequently used by his countrymen for the non-metallic elements, is "perfectly improper." It leads to the belief that all substances not strictly metallic are by their characters true quasi-metals. He announces that the barrier erected by Science between the metals and the non-metals is purely arbitrary and fictitious, whilst the latter class differ quite as widely among themselves as they do from the true metals.

When speaking of the theories of Newlands, Mendeleeff, and Meyer, M. de Saporta makes two remarks worth notice. He complains that the claims of priority, as between the three chemists just named, are difficult to decide. We have been of opinion that all disputes on this subject had come to an end with the publication of the original papers of Mr. Newlands. Secondly, our author calls attention to the fact that no French name has the right to figure along with those of the three authors just mentioned. But with this he does not consider that his countrymen can be justly reproached, since they excel rather in directing their experiments with clearness, and interpreting them correctly, than in hovering, like the Germans, amidst theories very elevated but often very cloudy.

He remarks that Mendeleeff aad L. Meyer return, in some sort, to the theory of chemical philosophy as laid down by Lavoisier and his immediate successors. He contends that the anomalies will disappear from the periodic tables, if, instead of fixing our attention on the free elements, their hydrides, or their chlorides, we consider the corresponding oxygen compounds.

The hypothesis of Prout is merely considered in a note.

Into the great questions of the origin and the nature of the received elements, and the prospect of their ultimate decomposition, the author does not enter.

The work may be regarded as a good compendium of the principles of chemistry valuable for readers acquainted with elementary details. The chief shortcoming which strikes us is the meagreness of the table of contents and the index.

CORRESPONDENCE.

ANCIENT MORTARS.

To the Editor of the Chemical News.

Sir,—*A propos* of Mr. Spiller's paper on the "Analysis of the Ancient Mortar from the Roman Wall of London" (Chemical News, vol. lviii., p. 189), and Mr. Irving's letter on the subject (vol. lviii., p. 219), perhaps I may be allowed to point out that about two years ago Messrs. Crookes, Odling, and Tidy presented a most important "Report on the Action of Water on Lead" to the Water Committee of the Huddersfield Corporation, in which it was stated that soft waters which had a solvent action upon lead could be rendered lead-proof by introduction of a certain proportion of silica. The silication was recommended to be carried out by means of a mixture of flint and limestone, but, as nearly as I can remember, no special reason was given for the use of these materials.

Messrs. Carnelley and Frew, in a paper on "The Corrosion of Leaden Water-pipes" (*Journ. Soc. Chemical Industry*, vol. vii., p. 15), call attention to the fact that while either sand or calcium carbonate added separately to distilled water exerts a protective action, a mixture of the two is even more effective. This result they explain by assuming the formation of calcium silicate, as they found that ground Wollastonite and *old mortar* acted in the same manner.

In the course of a recent investigation on this subject I had occasion to make a number of experiments very similar to those recorded in Messrs. Carnelley and Frew's interesting paper, and my results quite confirm their statements.

The rapid corrosive action of distilled water on lead in presence of air is, of course, well known. I found that sand or calcium carbonate, when added separately, prevented this action to a considerable extent, while a mixture of the two rendered distilled water practically lead-proof.

I think it probable, therefore, as Messrs. Carnelley and Frew have suggested, that the addition of sand to calcium carbonate, in presence of water, results in the formation of calcium silicate, and this comparatively quickly.—I am, &c.,

Rowland Williams.

28, Pall Mall, Manchester,
November 5, 1888.

The Formation of Amido-butyric Acid by the Direct Fixation of Ammonia upon Crotonic Acid.—M. Engel.—Crotonic acid fixes the elements of ammonia at 100°, and with great ease. The yield is almost theoretic, nothing being formed as a secondary product save a little oxybutyric acid. The product obtained is very probably β-amido-butyric acid.—*Bull. de la Soc. Chim. de Paris*, Vol. l., No. 2, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 15, October 8, 1888.

This number contains no chemical matter.

No. 16, October 15, 1888.

Certain Double Yttrium and Potassium or Sodium Phosphates.—A. Duboin.—The author has obtained the above phosphates by causing amorphous yttrium phosphate to react in the dry way upon potassium sulphate, or by causing pure yttria to react at a high temperature upon potassium or sodium metaphosphates and pyrophosphates.

Study of the Combustion-heat of Dextro- and Lævo-camphoric Acids, and of Camphora-racemic Acid.—W. Louguinine.—The author's object was to determine the influence of physical isomerism upon the heats of combustion. He found that no difference existed in this respect.

The Alkaloids of Cod-liver Oil.—Arm. Gautier and L. Morgues (continuation).—In this memoir the authors describe the fixed bases, aselline and morrhuine.

On Propylphycite.—Ad. Fauconnier.—The "propylphycite" described by Carius in 1865 is merely glycerin.

On the Latent Colours of Bodies.—G. Govi.—If we agree to consider as the peculiar colour of a body that which results from the radiations diffused or transmitted by such body in the greatest quantity, we may say that such peculiar colours are still very imperfectly known. The causes of this imperfect knowledge are as follows:—The light of the sun or diffused daylight not containing all the visible coloured radiations cannot always show us the true colours of bodies. Even the light given by incandescent solids which contain all the visible radiations, do not suffice to show us bodies in their true colour. To discover this true colour it is necessary to illuminate the bodies by a continuous complete spectrum containing neither rays nor absorption bands, or by simple radiations obtained from incandescent gases. These may be, and there really are, bodies whose peculiar colour is invisible or latent in the ordinary conditions of illumination.

No. 17, October 22, 1888.

Combination of Benzoic Aldehyd with the Polyatomic Alcohols.—H. Maquenne.—In the acetals derived from a polyvalent alcohol, each mol. of aldehyd necessarily saturates two alcoholic functions. If the number of these is odd the aldehyd will always leave at least one free, whence it results that the elementary composition of these acetals is so different when we pass from any polyatomic alcohol to its nearest homologue that analysis can distinguish them at once. Here, therefore, is a new means of determining if an alcohol as an even or odd atomicity.

Action of Hypophosphorous Acid upon Benzoic Aldehyd: Formation of a Dioxyphosphinic Acid.—J. Ville.—The facts observed by the author show that hypophosphorous acid unites with benzoic aldehyd to form a triatomic monobasic acid, the dioxyphosphinic or dioxybenzylene-phosphinic acid.

Action of Sodium Hypobromite upon Certain Nitrogenous Aromatic Derivatives, and Reaction Distinguishing the Hippuric and Benzoic Derivatives.—G. Denigés.—If we boil for a few moments a little sodium hypobromite containing an excess of alkali with a small quantity of hippuric acid or of a hippurite, a few bubbles of gas escape, and there is formed a reddish yellow turbidity which increases. The precipitate deposited is a bromine derivative, resembling a vermillion red powder. Benzoic acid, under the same conditions, gives nothing similar. Glycocol decolourises the hypobromite with an escape of nitrogen gas. The author has examined the action of sodium hypobromite with a number of compounds of the aromatic series, and has obtained the following results:—*Benzamide and Benzonitrile.*—Nothing in the cold, but a red precipitate on boiling. *Aniline.*—The aqueous solution, even if very dilute, gives an orange precipitate. *Methylaniline and Dimethylaniline.*—A yellow precipitate, rather greenish in the cold, but turning more to a red shade on boiling. *Toluidine.*—The same results as aniline, the precipitate rather more brown. *Anilides.*—Nothing in the cold; on boiling, a reddish precipitate. An odour of methyl cyanide is given off. *Metaphenylene-diamine Hydrochlorate, Diamido-benzoic Acid; Toluylene-diamine.*—A maroon-red precipitate both in cold and heat. *Ferrocyanides, Ferricyanides, Nitroprussides.*—On boiling, a red precipitate of ferric hydrate. *Pyridin.*—Nothing. *Quinolein.*—An orange-red precipitate only if aniline is present.

Bulletin de la Société Chimique de Paris. Vol. l., No. 2, July 20, 1888.

Action of Hydrochloric Acid upon Cupric Chloride: Hydrochlorate of Cupric Chloride.—M. Engel.—The author's results agree closely with those of M. Paul Sabatier (Chemical News, vol. lviii., p. 220).

Action of Hydrochloric Acid upon the Solubility of Stannous Chlorides: Hydrochlorate of Stannous Chloride.—M. Engel.—It results from the author's experiments that a definite hydrochlorate of stannous chloride may be obtained. It is crystalline, and melts about $-27°$.

Action of Hydrochloric Acid upon the Solubility of Cobalt Chloride: Hydrochlorate of Cobalt Chloride.—M. Engel.—This paper does not admit of useful abstraction.

On Neutral Platinum Chloride.—M. Engel.—There exists a neutral platinum chloride having the composition $PtCl_4 + 4H_2O$, and a hydrochlorate of the chloride $PtCl_4 + 2HCl + 6H_2O$. The latter oompound is the more soluble.

Analysis of a Mixture of Silver Chloride, Cyanide, Sulpho-cyanide, Ferricyanide, and Ferrocyanide.—Jules Teissier.—This question, which occurs in the analysis of mixtures serving for purifying coal-gas may be solved as follows:—We operate upon a saturated mixture of compounds derived from gas. After having exhausted with distilled water and eliminated the tarry matters by repeated boilings and filtrations, all the insoluble bases are precipitated by means of sodium carbonate, and all the acids capable of forming insoluble barium salts by means of barium nitrate. The last filtered liquid is precipitated with silver nitrate. The operations, including washing on the filter and the desiccation of the precipitate, are performed in the dark, and require eight days. The mixed precipitate is weighed and found 1825·7 m.grms. The equivalents of the five compounds being respectively 143·5, 134, 166, 536, and 322, if we denote by x, y, z, u, and v, the number of the equivalents of these compounds entering into the mixed precipitate, we have—

$$143{\cdot}5x + 134y + 166z + 536u + 322v = 1825{\cdot}7 \text{ m.grms.}$$

Carbonate of soda is heated in a large platinum crucible until completely dry; the mixed precipitate is then added, and then potassium nitrate. The crucible is closed and heated, first over a very small spirit lamp, and the heat is gradually increased by changing the lamp, a Bunsen burner being used at the conclusion. The total ignition lasts an hour. In this manner the sulphur of the sulpho-

cyanide passes into the state of potassium and sodium sulphate; the chlorine of the silver chloride passes also to the potassium and sodium. The contents of the crucible are exhausted with distilled water, metallic silver and ferric oxide being left undissolved. In the solution thus obtained the sulphur is determined as barium sulphate, and then the chlorine as silver chloride. For the former we find 2271·7 m.grms., whence the weight of the silver sulphocyanide=1618·5 m.grms. This is the value of $166z$ in the above equation. The silver chloride weighs 33 m.grms., the value of $143·5x$. The equation is thus reduced to $134y+536u+322v=174·2$. We have still three unknown quantities, to find which we dissolve in nitric acid the residue left at the bottom of the crucible. We determine the silver as chloride and the iron as ferric oxide. We find 1475·2 m.grms. of silver and less than 2 m.grms. of iron. Hence it may be regarded as an impurity, wherefore neither ferrocyanide nor ferricyanide are present and u and v are nul. $134y=174·2y=1·3$. The 1475·2 of silver chloride represent 1110·2 of metallic silver. Thus we have:—Silver chloride, 33·0 m.grm.; silver cyanide, 174·2 m.grm.; silver sulphocyanide, 1618·5 m.grm.

Chemical Study of the Essence of Eucalyptus Globulus.—R. Voiry.

Chemical Study of the Essence of Cajeput.—R. Voiry.—These papers have little general interest.

MISCELLANEOUS.

Society of Arts.—The One Hundred and Thirty-fifth Session will commence on Wednesday, the 21st November, with an Opening Address by the Duke of Abercorn, C.B., Chairman of the Council. Previous to Christmas there will be four Ordinary meetings, in addition to the Opening Meeting. At the first ordinary meeting of the Society a paper will be read by Colonel Gouraud, on "The Phonograph." This will be followed by one by Mr. Henry Edmunds, on "The Graphophone." At the other two meetings to be held before Christmas the papers will be by Mr. W. H. Deering on "Explosives," and by Mr. W. J. Dibdin, on "Standards of Light." Among the papers announced for the latter part of the Session may be mentioned—"Manufacture of Sèvres Porcelain," by Mr. E. Garnier (Director of the Sèvres Manufactory); "The Forth Bridge," by Mr. Benjamin Baker; "The Channel Tunnel," by Colonel Hozier; and "Secondary Batteries," by Mr. W. H. Preece, F.R.S. The first course of Cantor lectures will be by Captain W. de W. Abney, C.B., F.R.S., on "Light and Colour;" the other lecturers will be Mr. Alan S. Cole, Mr. W. J. Linton, Mr. Walter Crane, Mr. C. V. Boys, F.R.S., and Mr. H. Graham Harris. The Juvenile Lectures, at Christmas, will be given by Professor Henry E. Armstrong, Ph.D., F.R.S., the subject being a chemical one.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Waterproofing.—Has there ever been written an article or a book on waterproofing? If so I shall be glad of the title of it, the author's name, and the price. The information is required in connection with an important work.—Dr. Lorenz.

MEETINGS FOR THE WEEK.

Thursday, Nov. 15th.—Chemical, 8. Ballot for the Election of Fellows.

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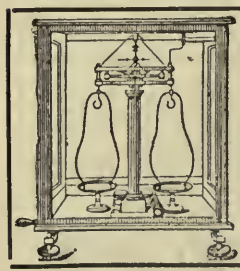

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THE CHEMICAL NEWS.

VOL. LVIII. No. 1512.

EXISTENCE OF A VOLATILE ALKALOID IN PEPPER.

By WILLIAM JOHNSTONE, Ph.D., F.I.C., &c.

THE subject of this short note is to announce the existence or discovery of a volatile alkaloid in pepper possessing strong alkaline properties. The analysis of its platinum salt gave the following results:—

		Found.	Calculated.
C	120·0	20·02	20·60
H	24·0	4·32	4·15
N	28·0	5·01	4·80
Pt	197·4	33·93	33·89
Cl	213·0	36·62	36·56
$2(C_5H_{11}N.HCl)PtCl_4$	582·4	99·90	100·00

These results so closely agree with the formula of piperidine that I think I am justified in announcing the existence of piperidine in pepper.

I have made several estimations of this volatile alkaloid in various peppers, and find that nine samples of black pepper gave an average of 0·56 per cent, with a minimum of 0·39 per cent and maximum of 0·77 per cent calculated as piperidine.

Long pepper contains 0·34 per cent, and pepper refuse composed principally of the husks 0·74 per cent.

Three samples of white pepper gave respectively 0·34, 0·21, and 0·42 per cent, showing that the alkaloid is contained principally in the husk, and which naturally accounts for the greater pungency of black pepper over that of white pepper.

The same samples of black pepper were examined for piperine and the amount estimated, giving a maximum of 13·03 per cent, a minimum of 5·21 per cent, and a mean of 8·25 per cent.

The City Central Laboratory,
13, Fish Street Hill, E.C.

ON BUMPING EBULLITION (SOUBRESAUTS).

By CHARLES TOMLINSON, F.R.S., F.C.S.

IN the CHEMICAL NEWS (vol. lvii., p. 244) was inserted a note from me on the above subject with reference to the recommendation of a German chemist to make use of pumice stone as a remedy for bumping. In the current number of the *Journal of the Chemical Society* an abstract is given of a paper by a Russian chemist, who recommends for the same purpose "a few very thin capillary glass tubes of [from] 3 to 10 m.m. in length, and sealed up at one end." The abstractor of the paper finds the suggestion "invaluable, especially for [*qy.* in.] the distillation of concentrated acids."

In January, 1869, I read a paper before the Royal Society "On the Action of Solid Nuclei in Liberating Vapour from Boiling Liquids." In this paper the whole subject of bumping ebullition is discussed, and the various proposed remedies practically examined, both as to success and failure. The value of porous bodies is insisted on, and estimated according to the increased amount of the distillate in distilling a variety of liquids. The practical value of these nuclei was further illustrated in a paper read before the Society of Arts on April 7, 1869, and printed, together with the discussion that followed the reading, in the Society's *Journal*. A number of experiments were performed to illustrate the leading points. The subject was also brought before the Pharmaceutical Society on May 18 in the same year, and was fully reported in the CHEMICAL NEWS.

With respect to the use of capillary tubes, I quote the following passage from my paper in the *Journal of the Society of Arts*.

"I have already said that these porous nuclei act by the force of capillarity, and so powerful is this force alone that it can be applied in a variety of ways. Even a short bundle of fine capillary tubes, united, like a faggot, by a thread in the middle, is an active nucleus in liberating vapour. Such a bundle, weighing only ten grains, put into a retort from which methylated spirit was being distilled, raised the amount of distillate in the ratio o 100 : 110."

The Russian chemist finds that charcoal acts only for a short time in preventing bumping. This may be the case with ordinary wood charcoal, but it is not so with well-prepared boxwood, or still better with cocoanut-shell charcoal, which will continue active for hours, and even days, making the boiling easy, and increasing the amount of the distillate. For example:—Methylated spirit, boiling at 171° F., distilled in a glass retort, gave 244 grains in five minutes, but when three or four fragments of boxwood and cocoanut-shell charcoal, weighing together 20 grains, were added, the distillate, in five minutes, weighed 325 grains, or as 100 : 133·2.

Highgate, N., Nov. 9, 1888.

ADULTERATION OF COAL-TAR NAPHTHA.

By THOMAS T. P. BRUCE WARREN.

COAL-TAR naphtha, as used by indiarubber manufacturers, is obtained, generally, from the crude products of the gas-works. There is no doubt a great deal obtained in the "carbonising process," used in preparing coke for smelting operations, which does not appear in commerce under a distinct name, although such naphtha is not unknown.

Generally, Newcastle or Cannel coal, or mixtures of these, are used in making coal-gas; hence the tar met with will vary more or less, and consequently the naphtha. The process of destructive distillation will introduce a variation in the composition of the naphtha recovered from such tar.

Petroleum products are now largely mixed with coal-tar naphtha. The advantages are that their greater volatility enables the spreading machines to be driven at three or four times the speed, whilst the diminished cost is greatly in its favour.

The low iodine absorption of petroleum and its commercial products, as compared with naphtha obtained from Newcastle coal, or mixtures used in gas-making, will readily reveal the fraudulent admixture of petroleum.

In the fractional distillation of such a mixture it is very important to examine each product.

SOME CURIOUS PROPERTIES OF METALS AND ALLOYS.*

By Professor W. CHANDLER ROBERTS-AUSTEN, F.R.S.

THE lecture consisted mainly of experimental demonstrations of the changes induced in metals, either by slight variations in the treatment to which they are subjected

* Abstract of a Lecture delivered before the Royal Institution o Great Britain, May 11, 1888.

or by rendering them impure by the addition of small quantities of metals or metalloids.

Prof. Austen began by pointing out that for centuries the early metallurgists investigated the action of exceedingly small quantities of matter upon masses of metal, and he said that, strange as it may seem, the promulgation, in 1803, of Dalton's atomic theory threw a flood of light upon chemical phenomena, but cast into shade such investigations as those of Bergman which dealt with influences of "traces" upon masses, and the authority of Berthollet was not sufficient to save them from neglect. In this eventful year for science, 1803, the latter published his essay on chemical statics, in which he stated, as a fundamental proposition, that in comparng the action of bodies on each other, which depends "upon their affinities and mutual proportions, the mass of each has to be considered."* His views were successfully contested by Proust, but, as Lothar Meyer says, the influence on chemistry of the rejection of Berthollet's views was remarkable: "All phenomena which could not be attributed to fixed atomic proportions were set aside as not truly chemical, and were neglected. Thus chemists forsook the bridge by which Berthollet had sought to unite the sister sciences, physics and chemistry." Fortunately, however, in this country there was one chemist who had followed up the line of work indicated by the early metallurgists, for in 1803, the same year as that in which both Berthollet's essay and Dalton's atomic theory were published, Charles Hatchett† communicated to the Royal Society the results of a research which he had conducted, with the assistance of Cavendish, in order to ascertain "the chemical effects produced on gold by different metallic substances when employed in certain" (often very small) "proportions as alloys."

Allusion was then made to the evidence of the passage of metals into allotropic states, and it was shown that although the importance of the isomeric and allotropic states was abundantly recognised in organic chemistry, it had been much neglected in the case of metals. Special attention was then devoted to the work of Joule and Lyon Playfair, who showed, in 1846, that metals in different allotropic states possessed different atomic volumes, and the lecturer then proceeded to the consideration of the work of Matthiessen who, in 1860, was led to the view that in certain cases when metals were alloyed, they passed into allotropic states, probably the most important generalisation which has as yet been made in connection with the molecular constitution of alloys.

Instances of allotropy in pure metals were then shown to the audience, such, for example, as Bolley's lead which oxidises readily in air; Schützenberger's copper; Fritsche's tin, which fell to powder when exposed to an exceptionally cold winter; Gore's antimony; Graham's palladium; and allotropic nickel. It was further shown that metals could be obtained in chemically active states under the following conditions:—Joule proved that when iron is released from its amalgam by distilling away the mercury the metallic iron takes fire on exposure to air, and is therefore clearly different from ordinary iron, and is, in fact, an allotropic form of iron. Moissan* has shown that similar effects are produced in the case of chromium and manganese, cobalt, and nickel, when released from their amalgams with mercury.

Evidence is not wanting of allotropy in metals released from solid alloys, as well as from fluid amalgams with mercury. Certain alloys may be viewed as solidified solutions, and when such bodies are treated with a suitable solvent, usually an acid, it often happens that one constituent metal is dissolved, and the other released in an insoluble form. Reference was then made to a new alloy of potassium and gold, containing about ten per cent. of the precious metal. If a fragment of this alloy be thrown upon water, the potassium takes fire, decomposes the water, and the gold is released as a black powder; there is a form of this black or dark brown gold which appears to be an allotropic modification of gold, as it combines with water to form auric hydride. By heating this dark gold to dull redness, it readily assumes the ordinary golden colour. The Japanese use this gold, released from gold-copper alloys, in a remarkable way, for they produce, by the aid of certain pickling solutions, a beautiful patina on copper which contains only two per cent. of gold, while even a trace of the latter metal is sufficient to alter the tint of the patina.

With regard to theoretical views as to molecular change in metals, special care was given to a description of the work of Professor W. Spring, of Liége, who had furnished much evidence in support of the view that polymerisation of metals, that is the rearrangement of atoms in their molecules, could take place even in *solid* alloys of lead and tin.

With reference to the passage of metals into allotropic states under slight external influences, it was stated that Debray* has given a case of an alloy in which a simple elevation of temperature induces allotropic change in the constituent metals. It is prepared as follows: ninety-five parts of zinc are alloyed by fusion with five parts af rhodium, and the alloy is treated with hydrochloric acid, which dissolves away the bulk of the zinc, leaving a rich rhodium-zinc alloy, containing about 80 per cent. of rhodium. When this alloy is heated in vacuo to a temperature of 400° C., a slight explosion takes place, but no gas is evolved, and the alloy is then insoluble in *aqua regia*, which dissolved it readily before the elevation of temperature caused it to change its state. We are thus presented (as the experiment shown to the audience proved) with another undoubted case of isomerism in alloys, the unstable, soluble modification of the alloy being capable of passing into the insoluble form by a comparatively slight elevation of temperature.

The industrial importance of the passage of metals and alloys into allotropic states, and the possibility of changing the mechanical properties of metals by apparently slight influences, was fully dealt with, and the lecture concluded with a detailed description of Professor Austen's own experiments which have since been printed in the *Philosophical Transactions* of the Royal Society, the results showing that very small amounts of metallic impurities exert an extraordinary effect on the tenacity and extensibility of gold, and that small as the amounts of these impurities are, their influence is rigidly controlled by the Periodic Law of Newlands and Mendeleeff, the deleterious action of a metallic impurity being in direct relation to its atomic volume. The audience was asked "to remember that the knowledge of the kind of facts which had been considered comes to us from very early times, for the influence produced on metals by small quantities of added matter had a remarkable effect on the development of chemistry, mainly by sustaining the belief of the early chemists in the possibility of ennobling a base metal so as to transmute it into gold. This was the object to which they devoted life and health, and laboured with fast and vigil. We inherit the results of their labours, and their prayers have been answered in a way they little anticipated, for, from an industrial point of view, if not from a scientific one, metals are 'transmuted' by traces of impurity. Possibly we are nearing an explanation of the causes which are at work, but the fact remains that iron may be changed from a plastic material, which in ornament can be fashioned into the most dainty lines of flow, into one of great endurance, to which, for the present at least, the defence of the country may be trusted, apparently because armour-plates and missiles owe their respective qualities to the fact that carbon, manganese, and chromium have small atomic volumes."

* English edition (by M. Farrell, M.D.), 1804, p. 5.
† *Phil. Trans.*, vol. xciii., p. 43, 1803.
‡ *Comptes Rendus*, vol. lxxxviii., p. 180, 1879.

* *Comptes Rendus*, vol. xc., p. 1195, 1880.

WAVE-LENGTHS OF METALLIC SPECTRA IN THE ULTRA VIOLET.*

By JOHN TROWBRIDGE and W. C. SABINE.

Part I.

Introduction.

The Catalogue of Metallic Spectra, revised by the Committee of the British Association, and published in its volumes for 1885 and 1887, is an extremely valuable contribution to the subject of spectrum analysis; it contains the material for future generalisation in regard to the molecular structure of so-called elements, or in regard to the harmonic relations which may exist between their wave-lengths. Here can be found in juxtaposition the results of various observers upon the metallic spectra of the same metal, and the student can judge of the relative accuracy of the results. A superficial inspection of this Catalogue will show that even distinguished observers, like Thalen and Kirchhoff, often differ in their results by one part in 4000, or one part in 2500. No observer of metallic spectra gives results to more than one-tenth of Angstrom's unit, or to more than one-tenth of one wave-length. Physical science, however, now demands a greater degree of accuracy. Various hypotheses in regard to the apparent coincidences between lines of metallic spectra and lines in the solar spectrum have been propounded, and can only be settled by more accurate measurements of wave-lengths. There are also questions constantly arising in regard to the displacement of lines of spectra due to the motion of the stars and to changes of temperature, which require a greater degree of accuracy in the measurement of wave-lengths of gaseous and metallic spectra than the results of previous observers afford. It may be remarked, that observations upon the metallic spectra of metals from the limits of the visible red to the limits of the visible violet have become comparatively easy; for the solar spectrum can be used to identify the lines of the metals and to ascertain their wave-lengths. It is only in the extreme infra red region and in the ultra violet that observations become difficult. In these regions we must trust to photography to reproduce by long exposures of the sensitive plate the feeble lines of metals which may manifest themselves there. In the infra red region, as far as wave-length 10,000, it is possible to photograph the solar lines, and we can compare the spectra of such metallic lines as may exist between the A line and the limit 10,000 with the solar spectrum. Beyond this limit, and beyond wave-length 2800 in the violet, the solar spectrum disappears, and the problem of measuring the wave-length of metallic lines which extend beyond these limits becomes a difficult one.

Besides the resolution of the difficulty of measuring the wave-lengths of the invisible rays of light with proper accuracy, the measurement of such wave-lengths is destined to prove a crucial test for various theories which must arise in the progress of physical science. The lines of the metals are exceedingly numerous in the ultra violet region, far more so than in the infra red region. If there are any harmonic relations between the wave-lengths of the spectra of metals, it is here that one might expect to observe such relations. Indeed, Professor Grünwald of Prague has lately enunciated a remarkable hypothesis upon the relations between the wave-lengths of so-called elements, and finds in the observations of various observers in the ultra violet a strong confirmation of his hypothesis. In any theoretical work upon the grouping of spectral lines, it is of fundamental importance that the wave-lengths of the lines should be determined with as great accuracy as possible. The coincidence of metallic lines with solar lines is at the best a doubtful piece of evidence. This evidence is of moment only when the number of coincidences becomes great, and is accompanied by characteristic grouping. A mistake of a wave-length in the question of position is sufficient to destroy the support which the author of any hypothesis might claim for it.

Conditions for Accuracy of Measurement.

All measurements of wave-lengths hitherto published have been made by the old method of angular measurements with a spectrometer. We say old, for the use of Rowland's concave grating with its peculiar mounting must be characterised as a new method and a new departure in measurements of wave-lengths. The observation of wave-lengths of metallic spectra by the eye is most laborious, and the photographic plate must be substituted for the eye for most purposes. The angular positions of the spectral lines on such a plate assume great importance, for upon these positions depend the value of the wave-lengths. In the operation of photographing spectral lines it is necessary to substitute for the observing telescope and micrometer eye-piece of the spectrometer a camera box provided with a suitable lens and with a plate holder for the photographic plate. Unless the latter is small the spectrum will not be in focus on all parts of the plate; moreover, unless the distance of the photographic plate from the diffraction grating employed is comparatively large, the distances between the spectral lines on the photograph will not be proportional to wave-lengths. To determine these wave-lengths recourse must be had to various devices. The one usually employed is due to Cornu, and can be found described in the *Annales de l'Ecole Normale*, 2 série, tom. iii., p. 421; also in *Journal de Physique*, x., 1881, p. 425. It consists in photographing images of the slit of the spectroscope upon the photographic plate by turning the graduated circle of the spectrometer through measured angles. These photographic images serve as fiducial marks, by means of which wave-lengths of spectral lines on the plate can be calculated. In the case of diffraction spectra obtained by deflecting a bundle of parallel rays at the angle of incidence, i, with a deviation of order n, Δ_n is connected to the wave-length λ, and with a certain constant, a, of the grating by the formula—

$$2\,a \sin \frac{\Delta_n}{2} \cos \left(i - \frac{\Delta_n}{2} \right) = n\lambda.$$

It is evident that at least two errors can arise in the use of this formula; one from defective graduation of the circle of the spectrometer; another from the process of referring from the photographs of the slit on the plate to the photographs of the metallic lines.

We select the work of Hartley and Adeney* as perhaps the best type of this method of using a camera with a spectrometer. Their work is characterised by great care and thoroughness, and no one could probably attain better results by the use of a flat grating, with its concomitants of collimator, photographing lens, and camera. These observers state that they were not troubled by the underlying spectrum of a higher order than that which they photographed, for it was not brought to a focus with the latter. In the new method we propose to illustrate, all the spectra are in focus together, and this fact, instead of being an obstacle, can be turned to great advantage. In the absolute measurements of the wave-length of light, the spectrometer method with eye observation and with a micrometer is unquestionably more accurate than any photographic method. We have in this determination to deal with comparatively large quantities, and with well defined directions, which can be made to coincide with optical axes of the instrument; this is not the case, however, with the majority of the spectral lines on a photographic plate placed in a camera, which replaces the observing telescope of the spectrometer. The photograph contains possible errors, and any shifting or movement of the spectrometer circle to determine intervals on the photographic plate is apt to introduce other errors.

* Contributions from the Jefferson Physical Laboratory.

* *Philosophical Transactions*, clxxv., 1884, pp. 63-137.

The ideal arrangement would seem, therefore, to be a photographic apparatus which should remain in focus for all the spectra of the different orders, in which distances between successive lines on the photographs of the spectra should be closely proportional to wave-lengths, so that, the constant being known for a certain position of the sensitive plate, the wave-lengths can be determined by simple linear measurement. Moreover, it is desirable, as we have said, that the underlying spectra should be brought to the same focus as the overlying; for by this means we can compare the wave-lengths of lines in the spectra of different orders, and halve our errors. It is true that some confusion results from having the metallic lines in the spectra of different orders photographed upon the same plate; but a little experience enables one to separate the lines with comparative ease, and the gain in accuracy compensates for the additional trouble.

The apparatus which best answers the requisitions we have pointed out is that of the concave grating of Rowland, with its peculiar mounting, which has been fully described in the *American Journal of Science*, vol. xxvi., 1883, p. 87.

Objects of the Present Investigation.

The conclusion of the work of the Committee of the British Association on the tabulation of metallic spectra seemed to us to require a survey of the work, which must be done in the future in order to perfect and correct the work of the past. We have therefore examined the tables given by the committee in order to see what lacunæ could be supplied, and to point out the directions for routine work which may afford material for future generalisations. In the pursuance of this work, we have been compelled to examine the accuracy of measurements of wave-lengths hitherto made in the ultra violet. With the aid of the new Map of the Solar Spectrum published by Professor Rowland, it is very easy to determine the wave-length of metallic lines in the visible spectra of metals; for it is merely necessary to photograph a portion of the solar spectrum upon the same plate as that which receives the spectra of the metals under consideration, and then to refer to the published map. We have already remarked, that even a superficial examination of hitherto published catalogues of wave-lengths of metallic spectra will show that distinguished observers differ in their determinations by one or two wave-lengths. The task of re-measuring the wave-lengths of metallic lines is a very great one, and approaches in character the routine work now prosecuted in astronomical observatories in the redetermination of star places, the photometric intensities of stars, and the classification of star spectra. In our present work we have confined our attention to ultra violet spectra. Since the solar spectrum disappears in the neighbourhood of wave-length 2800, the task of identification of wave-lengths becomes a very serious one. To replace the solar spectrum we must refer the lines of metallic spectra to carefully measured lines of certain metals. When one metal ceases to give spectral lines another must be selected. To test the relative accuracy of what we have termed the old method of measurement with that of the new, we have measured the lines of electrolytic copper, and have compared our results with those of previous observers in regard to the distribution of errors. Besides the comparison of accuracy, we have examined the limit of the spectra of copper in the ultra violet, in order to see if that given by previous observers could be extended.

Apparatus.

The apparatus consisted of a concave grating of 21 ft. 6 in. radius, mounted in the manner described by Professor Rowland. The camera was provided with a shutter, which enabled us to expose different portions of the sensitive plate at pleasure. An alterating dynamo machine was employed, together with a Ruhmkorf coil. The alterating machine gave from eight to ten thousand reversals per second. With a battery of from six to ten two-quart Leyden jars, a powerful spark was obtained between the metallic terminals which we employed. The spark was produced close to the slit of the apparatus, and the time of exposure varied from one to two hours. At various times endeavours were made to substitute the more powerful light of the carbon electric light for the electric spark, in the hope of shortening the time of exposure; but these efforts were not successful. If they had been, we should have been obliged to struggle with the question of impurities in the carbons. An exposure of fifteen minutes to the ultra violet spectra of metals burned in the electric light produced no image below wave-length 3000. A quartz condensing lens was employed with the arc light, and therefore no light was lost by selective absorption. With the spark no lens was necessary.

By curving the photographic plate, all parts of it remain in focus, and distances on the plate are closely proportioned to wave-lengths. Calling Y = wave-length, we have $Y = C + \alpha x$, where C and α are constants, and x is the distance along the plate.

The determination of the wave-lengths of lines extending over a range of three hundred tenth metres involved the taking of three negatives. The sensitive dry plate (2 × 10 inches) was pressed by springs against the "forms" of the plate-holder into an arc of a circle. Having placed the plate-holder on the camera box, the girder bearing the camera and grating was moved along its tracks until the position of the pointer of the carriage on the scale beside the track indicated that light of wave-lengths 4200 to 4800 in the first spectrum and 2100 to 2400 in the second spectrum would fall on the plate. The shutter was turned so as to expose only the lower half of the plate, and a photograph of the solar spectrum from 4200 to 4800 taken. The shutter was again turned, and the upper half of the plate given a long exposure to the light of the spark. Both spectra were in focus. The wave lengths of the metal lines were then found directly by interpolation on the normal spectrum, from the solar lines whose values were given in Rowland's Photographic Map and table of wave-lengths.* The interpolation was made by means of measurements on a dividing engine. In order to correct for any displacement due to the motion of the spark from side to side, or to jarring arising from the great noise of the spark, and also in order to sift out the lines belonging to the first spectrum from those belonging to the second, the girder was moved to the violet of the third, with its magnified dispersion and different underlying spectra. The metal and solar lines were taken side by side, and the interpolation for the wave-lengths of the metal lines made as before. From this the correction to be applied to the previous plate was found, amounting in some cases to 0·2 of a tenth metre. The correction thus found was applied to all of the lines on the plate. The girder was now moved so that the sensitive plate was in the extreme ultra violet of the first spectrum, and the plate exposed to the light from the spark. From this negative the value of the wave-lengths of the faint lines were obtained by interpolation from the values of the stronger lines as determined by the first plate. It also served as the final test whether the lines on the first negative were of the first or second order. All of the lines more refrangible than line 2123·1 were, in the case of copper, found from this negative and from line 2136·1 by direct measurement.

Another method of distinguishing which lines on the first negative belong to the second and which to the first spectrum, is to place in front of the slit, while taking the metal lines, a piece of plane glass. The second spectrum for this refrangibility will be completely cut out, and only the metal lines of the first remain, being in the visible violet.

The only source of error was in the setting of the microscope upon the broad or faint lines. The probable

* *American Journal of Science*, March, 1887.

error of this is about 0·1 tenth metre. For the few most refrangible lines it may be greater.

(To be continued).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, November 1st, 1888.

Mr. William Crookes, F.R.S., President, in the Chair.

Messrs. James Schleselman and Henry A. Miers were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Charles M. Adams, 29, Mosley Street, Newcastle-on-Tyne; John Hope Belcher, B.A., Craigmount, Edinburgh; Percy Carter Bell, The Cliff, Higher Broughton, Manchester; William Berry, Hampton Park, Redland, Bristol; William D. Bohm, 51, The Avenue, Acton; Frank Bower, 37, Lansdowne Road, Clapham Road, S.W.; James E. Brunker, Minore, Saint Kevin's Park, Rathmines, Dublin; George Alexander Byrn, Technical College, Sydney; John Morrow Campbell, 22, Regent Moray Street, Glasgow; Vaughan Cornish, B.Sc., High School, Newcastle-under-Lyme, Staffs.; William Douglas, A.I.C., Diamond, Demerara; Arthur G. Everard, North Street, Bishop's Stortford, Herts; Henry Forth, 1, Beech Avenue, Sherwood Rise, Nottingham; Frederick B. Guthrie, 65, Portland Road, Notting Hill, W.; John Lawrence Van Guyzel, Indian Medical Service, Madras; John Hansfield, Waterfoot, near Manchester; Urban Arthur Jackson, 2, New Bridge Street, Strangeways, Manchester; Alfred Battye Knaggs, Ebor Mount, Huddersfield; Oscar Lowman, B.A., Ph.D., 66, West 8th Street, Cincinnati, Ohio; William Marshall, The Baths, Saint Andrews, N.B.; George Edward Perry, 6, Norward Villas, Edgbaston, Birmingham; Hubert Naylor Bardsley Richardson, Elmfield, Knighton, Leicester; John S. Rigby, Bagot Street, Liverpool; John Sanderson, 57, Belsize Park Gardens, London, N.W.; Thomas Oliver Landolt, Baron's Court Road, West Kensington; William Jay Schieffelin, Areis Strasse, 1, Munich; Arthur Landaner Stern, Bass & Co's. Old Brewery, Burton-on-Trent; William Taylor, Hong Kong; Charles Turner, 25, Sidney Street, Cambridge; J. T. Ainslie Walker, Hope Cottage, Winchburgh, Linlithgowshire; Edward Dalrymple Walrond, B.A., North Eastern County School, Barnard Castle, Durham; Frederick Walmesley Warrick, 136, Southampton Row, W.C.; Edward J. Way, Transvaal Gold Exploration Company, Transvaal; Ernest William Whieldon, 42, Worthingham Road, East Dulwich; R. W. Woosnam, York House, Southend-on-Sea.

The following papers were read:—

72. "*The Constitution of the Terpenes and of Benzene.*" By William A. Tilden, D.Sc., F.R.S.

With the object of testing further the current hypothesis concerning the constitution of the terpenes, the author has made a series of quantitative estimations of the amount of paratoluic acid produced by the oxidation of several of the terpenes with dilute nitric acid in comparison with the amount of the same product formed under the same conditions from cymene and from paraxylene. The following results were obtained:—

100 parts by weight give of paratoluic acid—

Cymene (from turpentine)	80·1
Cymene (from cumin oil)	73·1
Paraxylene (Kahlbaum's)	77·2
Australene from American turpentine	1·2
Terebenthene from French turpentine	1·9
Hesperidene from orange oil	0·0
Dipentene from $C_{10}H_{16}{\cdot}2HCl$ obtained from terpin	27·6

An experiment on a larger scale with hesperidene showed that the chief product of its oxidation by nitric acid is oxalic acid: Using chromic acid mixture, Wright and Beckett found that acetic acid was the only product.

The characteristic properties of the terpenes as a class—the readiness with which they polymerise by heat or contact with a small quantity of sulphuric acid, the eagerness with which they combine with bromine, with hydracids, and in some cases with the elements of water, and the nature of their products of oxidation—are such that they differ wholly from all known benzenoid hydrocarbons.

In order to settle the limit of the combining capacity of the chief terpenes about which there is some difference of statement on the part of different authors, the amount of bromine taken up by the hydrocarbon was determined. From the several experiments made in each case the following numbers were deduced.

136 parts or 1 mol. proportion of the hydrocarbon combines with the following quantities of bromine:—

Australene	313
Terebenthene	307
Hesperidene	322
Dipentene (terpilene)	297
Calculated for Br_2	160
" " $2Br_2$	320

In all cases the hydrocarbon unites with four atoms of bromine and no more. Camphene does not combine with bromine and hence must be regarded as saturated in the usual sense.

Since the terpenes possess at most four units of available combining capacity, the nucleus of six carbon atoms, which they all undoubtedly contain, cannot be supposed to form an open chain. They must be united into a closed chain containing at the most two double bonds. Hence formulæ of the character of those proposed originally by Oppenheim, and later by Goldschmidt and Zurrer, by Wallach and Brühl are the most probable. Such formulæ represent the molecule as constructed upon the basis of a ring of six carbon atoms disposed in the manner which has been so long familiar in Kekulé's formula for benzene. But since the terpenes are certainly not benzene-derivatives, Kekulé's formula must be abandoned. The evidence in support of this conclusion is not derived solely from the foregoing considerations; which standing alone would probably be regarded as inconclusive. The chief objection which has been urged against Kekulé's formula is based upon the difference in the nature of the link between the carbons which stand in the relative positions 1 : 2 and 1 : 6. The hypothesis devised by Kekulé himself to meet this difficulty cannot be regarded as satisfactory. Another objection to the symbol is that benzene is represented as containing "ethylenic" carbon, for which there is no evidence at all; moreover a body of this formula when treated with nitric acid ought to yield abundance of oxalic acid: this the terpenes do, but the benzenoid hydrocarbons do not.

The characteristics of the benzenoid hydrocarbons and their derivatives may be explained by the formulæ proposed by Claus, by Ladenburg, and by Armstrong and von Baeyer, but at present there is not sufficient evidence to enable us to decide between them.

As to the terpenes, the conclusions derived from their refraction equivalents are so much at variance with the chemical behaviour of many members of the group that they cannot be accepted without considerable qualification. Such other physical evidence as is deducible from the work of Hartley, and of Abney and Festing, tells entirely against the assumption that the terpenes are derivatives of benzene.

Discussion.

Referring to Professor Tilden's statement that it was an objection to Kekulé's formula that benzene did not yield oxalic acid on oxidation, Dr. Japp said that phenol

he believed, gave a considerable quantity of the acid on oxidation with alkaline permanganate.

Mr. Groves added that oxalic acid was obtained in quantity on oxidation of chloranilic acid; and Dr. Perkin remarked that he had obtained a quantity of oxalic acid in preparing picric acid from phenol.

Dr. Perkin said that the magnetic rotatory power of American turpentine was remarkably low, which was a probable indication of the non-existence of a C_6 nucleus.

Dr. Armstrong expressed the opinion that the evidence at disposal was entirely insufficient to enable us to determine the constitution of the terpenes with any degree of probability. He could not accept Dr. Tilden's conclusion that camphene was saturated, as it readily united with a molecular proportion of hydrogen chloride. With regard to the constitution of benzene, his main contention was that the cross connexion of carbon atoms exhibited in Claus's and similar formulæ was inconceivable; be believed that corresponding carbon atoms could exercise an influence upon each other although unconnected except indirectly.

Professor Tilden said that his chief object in referring to the constitution of benzene was to emphasize his opinion that whatever the nature of the combination between the carbon atoms, it did not correspond to that which obtained in ethylene.

73. "*Some New Compounds of Magnesia with the Halogens: A Contribution to the Study of the Electrolysis of Magnesium Chloride Solution.*" By C. F. Cross and E. J. Bevan.

Their observations on the electrolysis of magnesium chloride in aqueous solution, which is now a process of preparing bleaching solutions on the large scale, had previously made the authors aware that the decomposition was attended by interactions *not* to be explained on the view commonly held, viz., that the ions are magnesium and chlorine, which by secondary interactions give rise to magnesia and hypochlorous acid.

With the view of elucidating the actual mechanism of the electrolysis, the authors have studied in the first instance the phenomena at the cathode. The white substance separated under the condition that the solution is not kept in circulation, is not magnesia (hydrate), but a chloroxygen compound of magnesium, in which the ratio of Cl to total oxidising power expressed as Cl is approximately 1 : 2. It may be regarded, therefore, as a magnesium hypochlorite. It is worthy of note that the percentage weight of "total oxidising Cl" lies between 30 and 35, calculated on the anhydrous substance. The compounds described were analysed in the freshly prepared and hydrated condition. They differ from the normal magnesium hypochlorite not only in being insoluble, but also in point of their stability.

Similar compounds were obtained on electrolysing solutions of magnesium bromide and magnesium iodide, though in the case of the latter the ratio—total oxidising iodine: Iodine as silver iodine—is considerably less than 2, viz., approximately 6 : 5. Nevertheless, the compound decomposes ammonia with evolution of nitrogen, and is in all its properties rather a compound than a mixture of iodine with magnesia.

The authors are engaged in studying the phenomena to be observed at the anode during the electrolysis in question, and the composition of the resulting solution in regard to the whole of the chloroxygen compounds, of which there appear to be at least two.

74. "*The Heat of Dissolution of Various Substances in Different Liquids.*" By S. U. Pickering.

The author has explained the constancy of the heat of neutralisation of acids by alkalies on the view that the affinity of the radicles composing the salt molecules concerned is not entirely saturated by their combination, and that the residual affinity of one of these radicles becomes in each case entirely saturated by the solvent. The heat of combination of the atoms, and the heat of dissolution of the molecules which they form, are thus parts of the same operation, and must therefore both be chemical in their nature. Dr. Nicol has suggested the possibility of the heat of dissolution of the molecules of four solids showing the relation expressed by—

$$MR_1aq - M'R_1aq = MR'_1aq - M'R'_1aq,$$

which would render the above-mentioned connexion between the heat of dissolution and formation of the molecules unnecessary. The author shows that if Dr. Nicol's suggestion held good a certain relationship would obtain between the heat of dissolution of two pairs of salts in two different liquids. To investigate this he has determined the heat of dissolution of the nitrates and chlorides of calcium and lithium in water and in alcohol, and has found that they give results showing a difference of 4461 cal., where, according to Dr. Nicol's view, there should be no difference at all.

Other salts were also examined and it was found that the heat of dissolution in alcohol was sometimes greater and sometimes less than in water.

According to the author's views the heat of dissolution should be the same whatever the solvent were, provided (1) that the residual affinity of one only of the radicles constituting the dissolved substance be saturated by the solvent, and (2) that the saturation be effected by *free* affinity of the solvent, *i.e.*, that no alteration in the force with which the molecules or atoms of the solvent are united together be involved. The first condition is ensured by taking an elementary substance instead of a salt; and the author has found that the heats of dissolution of iodine and bromine in various liquids give much more nearly identical results than salts do, and that with liquids containing no oxygen the results are identical within experimental error. Oxygenated liquids give higher results, and the presence of sulphur as a constituent element of the solvent has, to a certain extent, the same effect as oxygen. If the second as well as the first above-mentioned conditions could be secured, the results would probably be in all cases identical.

Discussion.

Professor Ramsay said it appeared that the heats of dissolution of iodine in various media might be arranged in two well-defined groups. Might not this be correlated with the fact that iodine dissolves in certain liquids forming a brown solution, and in others forming a violet solution; and with the observation recently made by Loeb that iodine existed in these differently coloured solutions in different molecular states.

75. "*The Criteria of Plane and Axial Symmetry.*" By Henry E. Armstrong.

Wislicenus, in his now widely known paper on the space arrangement of the atoms in carbon compounds, has termed compounds of the form $\begin{matrix} a.C.b \\ \| \\ b.C.a \end{matrix}$ *axially symmetric*, and those of the form $\begin{matrix} a.C.b \\ \| \\ a.C.b \end{matrix}$ *plane symmetric*. In allocating these formulæ he has argued in a case such as is afforded by the two tolane dichlorides, for example, that the compound of higher melting-point (143°) is necessarily the plane symmetric modification, as it is produced on chlorinating tolane—

$$\begin{matrix} C_6H_5.C \\ \\ C_6H_5.C \end{matrix} \ldots + Cl_2 = \begin{matrix} C_6H_3.C\ Cl \\ .. \\ C_6H_3.C\ Cl \end{matrix};$$

and he urges that this conclusion derives support from the behaviour of tolane tetrachloride on reduction. Of the three possible configurations which this compound may acquire, viz.:—

$C.C_6H_5Cl\ Cl$	$C.C_6H_5Cl\ Cl$	$C\ C_6H_5Cl\ Cl$
$\dot{C}.ClC_6H_5Cl$	$\dot{C}.Cl\ ClC_6H_5$	$\dot{C}\ C_6H_5Cl\ Cl'$

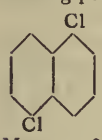
he regards the first and second as far the most likely to

exist especially at low temperatures; both would furnish on withdrawal of two corresponding chlorine atoms the same axially symmetric tolane dichloride, and it is therefore to be supposed that the modification formed in larger quantity on reducing the tetrachloride would be this modification. According to the recent experiment of Blank (*Annalen.*, ccxlviii., 1), the two isomeric dichlorides are obtained nearly in the proportion of two parts of that of lower melting-point (63°) to one of that of higher melting-point; and the axially symmetric structure is therefore, it would seem, as a matter of course, assigned by him to the compound of lower melting-point.

The first argument is only valid provided that at the moment of change no isomeric change supervenes, and must be accepted with reserve—if not regarded as altogether untrustworthy—as further study of the changes involved in the production of isomeric compounds appears to make it more and more probable that the final product is very frequently the product of an unperceived isomeric change (cf. *Proceedings*, 1887, Abstr. Nos. 99—101; 1888, Abstr. Nos. 50 and 51).

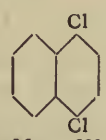
The second is not an argument based on clearly ascertained facts, but derives its force entirely from hypothetical views as to the relative affinities of the radicles present in a compound, and the effect on the ultimate configuration which these affinities would have, and is especially based on the conventional assumption that dissimilar radicles would tend to influence and attract each other more than would similar radicles. But it is to be remembered that we have little certain knowledge of the relative affinities of different radicles, especially of similar as compared with those of dissimilar radicles; indeed, that our views are not based on the study of the radicles themselves, but are mere inferences from the apparent behaviour of the radicles in their compounds. Moreover, Thomsen's observations on the heats of combustion of chlorine compounds may be held to some extent to favour a view contrary to that put forward by Wislicenus (cf. *Phil. Mag.*, 1887 [5], xxiii., 106).

The most important argument averse to the interpretation given by Wislicenus, however, is to be found in the fact that in cases in which the constitution may fairly be regarded as established, the relation between configuration and physical properties is of the obverse order to that indicated by Wislicenus. Thus in the case of benzene di-derivatives the symmetric or para-derivative has always the highest melting-point; the same appears to be true of the symmetric tri- and tetra-derivatives; and in the case of naphthalene, in a series of isomeric di-derivatives, the axially symmetric modification is always that of highest melting-point, thus—

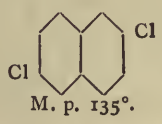


M. p. 107°.

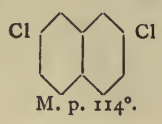
M. p. 83°.



M. p. 68°.



M. p. 135°.



M. p. 114°.

Again, of the four known naphthalene-disulphonic chlorides, the axially symmetric $\alpha'\alpha^{4'}$ modification melts at 183°, the dissymmetric $\alpha\beta$ modification at 128°, the axially symmetric $\beta^2\beta^{3'}$ modification at 226°, and the plane symmetric $\beta^2\beta^{2'}$ modification at 160°.

Employing the argument from analogy, it is therefore probable that the tolane dichloride melting at 143° is the axially symmetric, and that melting at 63°, the plane symmetric modification, and also, for example, that elaidic acid—and not oleic acid as Wislicenus assumes—has the "axial" structure. In the case of maleic and fumaric acids, the argument here relied on would support the conclusion already arrived at by Van't Hoff and accepted by Wislicenus, which, however, is based not on geometric considerations, but on the observed property of maleic acid to form an anhydride.

It is a noteworthy fact that the majority of "allo-isomerides"—to use a term which is sufficiently expressive while it does not beg the question as to the determining cause of the isomerism—are compounds containing unsaturated carbon, usually in association with one of the halogens or oxygen. It does not appear that this circumstance has yet been taken into account, or that the extent to which the peculiarities manifested by the negative elements are concerned in and may condition the isomerism has been in the least considered. The symbolic system introduced by Van't Hoff and adopted by Wislicenus tends to withdraw attention from the consideration of the possible effect of the peculiarities referred to, inasmuch as a "double bond" is represented as the precise equivalent of two, and a treble bond as that of three single bonds; which all observations show is a misrepresentation of the facts.

76. "*Derivatives of Methylindole.*" By H. G. Colman, Ph.D., B.Sc.

By the action of sodium hypobromite solution on methylindole or methylindole-carboxylic acid, Fischer and Hess (*Ber.*, xxii., 561) obtained a brominated compound which on treatment with alkali yielded methylpseudisatin.

It is shown that the brominated substance is dibromomethyloxindole, a white crystalline substance melting with decomposition at 204°.

If sodium hypochlorite be substituted for sodium hypobromite, the corresponding dichloromethyloxindole is obtained m.p. 145—147°. Both compounds on boiling with alkali, or better with water, yield methylpseudisatin. The phenylhydrazone and oxime of the latter have been prepared: they are yellow crystalline compounds melting at 145—146° and 180—183° respectively.

By the reduction of dibromethyloxindole in acid solution, monobromomethyloxindole and methyloxindole are successively obtained. Both are white crystalline compounds, the former melting at 132—134°, and the latter at 86—88°.

Methylpseudisatin, on reduction in acid or alkaline solution, yields methyldioxindole; this crystallises from benzene in needles or prisms melting at 149—151°.

77. "*Acetamide and Phenanthraquinone.*" By Arthur T. Mason, Ph.D., F.I.C.

The author finds that when oximide is heated in sealed tubes with glacial acetic acid at 220—230° C., acetamide is formed, which, however, on re-crystallisation from ether or benzene totally loses the peculiar smell of mice excrement which has hitherto been supposed to be its principal characteristic. Ordinary acetamide prepared by the distillation of ammonium acetate also becomes odourless by twice rectifying and rejecting the first portions of the distillate.

Acetamide when heated with phenanthraquinone in sealed tubes at 220—230° C., using glacial acetic acid as solvent, yields diphenanthrapiazine, an indifferent body, having a melting-point over 400° C. and belonging to the "azine" group.

78. "*The Action of Ethylenediamine on Succinic Acid.*" By Arthur T. Mason, Ph.D., F.I.C.

The addition compound, $C_2H_4(COOH)_2{\cdot}C_2H_4(NH_2)_2$, is first produced; it crystallises in thick white prisms melting at 181—182°; if it be heated above this temperature it parts with water, ethylenedisuccinimide,—

$$\begin{matrix} CH_2{\cdot}CO \\ CH_2{\cdot}CO \end{matrix}\!\!>\!N{\cdot}CH_2{\cdot}CH_2{\cdot}N\!<\!\!\begin{matrix} CO{\cdot}CH_2 \\ CO{\cdot}CH_2 \end{matrix},$$

being formed which melts at 250—251°, and distils undecomposed at 395°. This compound gives the pyrrole reaction on distillation with zinc-dust containing hydroxide. It is not attacked by bromine and water at

120°, but at 180° ethylenediamine bromhydride is formed. Ethylene disuccinamic acid,—

$$COOH{\cdot}C_2H_4{\cdot}CO{\cdot}NH{\cdot}C_2H_4{\cdot}NH{\cdot}CO{\cdot}C_2H_4{\cdot}COOH,$$

is prepared from the diimide by boiling with baryta-water; the acid crystallises from water in large, colourless quadratic plates melting at 184—185°; its silver salt is anhydrous; the calcium salt has the formula—

$$C_{10}H_{14}N_2O_6Ca+3H_2O.$$

NOTICES OF BOOKS.

Dyeing: Comprising the Dyeing and Bleaching of Wool, Silk, Cotton, Flax, Hemp, China Grass, &c. By Antonio Sansone. Manchester A. Heywood and Son. London: Simpkin, Marshall, and Co., and Hamilton, Adams, and Co.

The volume before us is a worthy companion to the author's former work, "The Printing of Cotton Fabrics," and as far as the extent of 250 pages will allow, it gives a very complete and practical view of dyeing, as at present carried on in the leading seats of tinctorial industry.

The work opens with four introductory chapters. The first of these, on the "History of Dyeing," though brief, contains some interesting facts not generally known. Another chapter is allotted to the history of the coal-tar colours, from the first production of an aniline violet, down to the present day. This section concludes with an important remark:—"On the whole, it seems that the field of coal-tar colours, which has been found so rich, and given rise to so many brilliant discoveries, shows, now, signs of exhaustion (as far as really useful products are concerned), and the hopes of those who believed that all natural organic colouring-matters would be artificially produced on a large and commercial scale have, up to now, not been realised." Surely the displacement of natural colours by artificial products, whether probable or not, is not to be hoped for. Whatever tends to draw men from the open country and the fields or plantations into the cities and the factories is to be deprecated on social and sanitary grounds. It would be better to aim at methods by which the colour-yielding plants might be improved and ennobled, so as to yield tinctorial matters more abundant in quantity and better in quality. Analogous improvements are well known to have been effected in the vegetable world.

In the chapter on the characteristics of fibres we find quoted the opinion of M. Buisine that it would be remunerative to extract certain organic acids from the washings of wool. In 100 parts of the dry suint of Australian wool there were contained 7·1 acetic acid, 4 propionic, 2·6 benzoic, 2·5 lactic, and 1 caprylic acid.

In a fourth chapter Mr. Sansone proceeds to the testing of colouring-matters by dyeing. He seems entirely to reject the purely chemical methods, gravimetric or volumetric. He admits that they "may yield trustworthy results in the hands of the skilful chemist," but considers that they are not capable of general application, and are therefore seldom used in practice. It may be replied, however, that the comparative dyeing tests which the author recommends give trustworthy results only in skilful hands, as he substantially admits, and that where a previous mordanting is required, the time such tests require is an objection.

After these preliminaries we find an account of practical processes as applied to cotton, linen, jute, wool, and silk.

The topping vat blues with methyl violet is very properly pronounced a sophistication, since the effect produced is fugitive. The electrical vat, whatever development it may possibly undergo in the future, Mr. Sansone considers at present too costly and complicated to be of any real utility. From this opinion few men of experience will dissent.

Concerning jute, the author states that though the basic aniline dyes take easily on this fibre without any mordant, owing to the tannin naturally present, they fade very readily.

Under wool dyeing the author recommends the Cerrutti-Sella apparatus as advantageous for this fibre in every state in which it has to be dyed.

The basic aniline colours have lost much of their importance in wool dyeing since the introduction of the acid colours. One passage in this connection seems unintelligible from some probable clerical or typographical error. We read:—"*Bismarck brown*, chrysoidine, and phosphine the violets." As none of the colours here mentioned are violets the reader is left in doubt.

The dye-wood colours, as a whole, are said to have still held their own, a circumstance which we, in this country, have no reason to regret. Cochineal, however, has suffered very considerably.

We are very glad to find that the author decidedly condemns the weighting of silks as a fraud. This art "has been the cause of injuring the prosperity of the silk industry very considerably, and this beautiful fibre, which in olden time was the symbol of strength and durability, is now-a-days simply the emblem of the hollow and presumptuous show in which this age heartily delights." However, nothing but legislative interference can now avail to meet this evil.

The last portion of the book discusses new colouring-matters and a variety of miscellaneous matter.

The illustrations of this book are particularly excellent and instructive. There are forty-five plates showing the most improved machinery used in bleaching and dyeing. In the patterns illustrating different colours we notice a decided improvement. Not only are they beautifully got up, but instead of being pasted in among the text, where they get soiled, they are placed in a case, forming in fact a second volume.

Mr. Sansone deserves the thanks of all persons connected with the trade for this important addition to our tinctorial literature, and the publishers, Messrs. Heywood and Son, deserve our congratulations on the getting up of the volume.

CORRESPONDENCE.

WATERPROOFING.

To the Editor of the Chemical News.

Sir,—In answer to your correspondent, I am not aware of any article or book having been written, dealing in a special way with this subject. Spon's "Encyclopædia," article "Indiarubber," contains an article bearing on the matter *generally*. Hoffer's "Indiarubber," translated by Brandt, New York, contains an article on the same subject.

In treating of this matter the general principles of drying and preparing the fabric to be *proofed*, the preparation of the "dough," or proofing compound, evaporation of naphtha, &c., doubling, and curing, can be seen in operation at most factories. The only variation consists in minor details, as in any manufacturing industry.—I am, &c.,

Thomas T. P. Bruce Warren.

Tamworth Villa, Earlham Grove,
Forest Gate, E.

SULPHUR IN IRON.

To the Editor of the Chemical News.

Sir,—In the Chemical News (vol. lviii., p. 177) there appeared an article by H. N. Warren on "The Dissolution of Sulphur and Phosphorus, as Observed . . ." In this

article, since FeS appears to be found after electrolysis, the theory is advanced as plausible "that the compound expressed by the formula FeS is the only combination obtainable by the simple action of sulphur on metallic iron, aided by heat, and that the sulphur does not disseminate itself throughout the whole mass of metal to form a compound possessing a formula where iron predominates largely, such as would be inferred from the formula expressed by Fe_8S, and which could be arrived at by calculating from analytical data; but exists rather in the form of sulphide of iron, disseminated, so to speak, through a mass of pure iron, the sulphide present forming a simple network, allowing the current free passage; the iron, being a much superior conductor of electricity than the sulphide, becomes more rapidly dissolved, leaving the residual sulphide."

With all due respect to the writer's judgment, I cannot agree with him. In the arrangement described the $FeCl_2$ would be decomposed by the current, the Cl combining with the iron of the electrode, while the sulphur, if combined with the iron in *any* proportion, being separated in a short time, would be present on the surface of the electrode in sufficient quantity to give FeS, or even possibly FeS_2.

So often theories are advanced without sufficient reason, that it seems to me a protest should be uttered whenever possible in such cases.—I am, &c.,

Clarence L. Speyers.

State University of Missouri,
Chemical Laboratory, Columbia, Mo.,
October 26, 1888.

ANCIENT MORTARS.

To the Editor of the Chemical News.

Sir,—The facts enumerated by Mr. Rowland Williams (Chemical News, vol. lviii., p. 231) are (though not new) very interesting in their way, but can scarcely be said to throw much new light on the point raised in connection with Mr. Spiller's examination of ancient Roman mortars until a certain ambiguity, at present running through the language employed in stating those facts, is removed. To be exact, Mr. Williams must tell us the true nature of the "sand" employed in the cases he mentions. Normal clean quartzose sand is, as everybody knows, a congeries of particles of crystalline SiO_2; but such a sand occurs but rarely in nature; probably never, unless it has had all ferruginous or other investment of the grains removed by the leaching action of either organic acids or (in volcanic regions) mineral acids dissolved in water percolating through the deposit. Until this point, therefore, is settled, we must hesitate to draw any certain inference from the alleged facts.

Again, the geologist knows perfectly well that even clean "sands" vary in composition within rather wide limits, from a congeries of particles of rock-crystal, at one end of the series, through mixtures of SiO_2 with comminuted felspathic, micaceous, and other silicates, to the pumiceous dust (a mixture of fragmental glassy or hydro-devitrified silicates), which constitutes normal volcanic sand at the other end of the series. Until we have precise information on these points we must "suspend judgment."

Once more, Mr. Williams makes no allowance for the many allotropic forms which SiO_2 assumes in nature. The differences in molecular structure which undoubtedly accompany such variations of the same chemical body as are exhibited (*e.g.*) by rock-crystal, flint, or opal, make a great difference in the readiness with which these varieties of SiO_2 (as well as silicates) lend themselves to reactions upon other substances, as has been very well shown by Rammelsberg. This point I have more fully discussed elsewhere, and herein, no doubt lies the value of the "ground flint" recommended by Messrs. Crookes, Odling, and Tidy in the case of the Huddersfield water supply. This point was brought before Section B of the British Association at Birmingham, in 1886, by Messrs Crookes and Tidy; but one of them informed me that the removal of lead was proved to consist in the formation of *silicate of lead*. From the close relation in which lead stands to the bases of the alkaline earths we should expect silicate of lime to be formed under similar conditions; but are the conditions similar in the two cases?

Having been engaged a good deal in the study of reactions of this class during the past year or two, I am quite prepared to find that in the cases mentioned by Messrs. Carnelley and Frew the "sand" employed furnished a considerable proportion of felspar or other silicates to do what Wollastonite itself was found to do; that is (probably), to furnish bases strong enough to take hold of CO_2 from carbonate of lead, and at the same time to furnish nascent SiO_2 to form silicate of lead, just as free SiO_2 in the form of a semi-vitreous colloid (as it occurs in native flint) was found to do. The effect of passing native waters through carbonate of lime (whether in the form of "old mortar" or not) is simply to apply the most commonplace fact of physical geology by giving calcareous hardness to the water; and the immunity of hard waters from lead contamination is equally well known.

How calcium silicate (Wollastonite) can aid as an *antecedent* to the reaction whereby lead is fixed in an insoluble form, and yet be a *consequent* of the reaction under the same physical conditions I fail to understand. Does not this remind one rather of such fond dreams as "perpetual motion"?

We are still confronted—as I consider—with the question as to the nature of the sand employed in the "ancient mortars," of the Roman builders.—I am, &c.,

A. Irving.

Wellington College, Berks,
Nov. 10, 1888.

REWARDS FOR MERITORIOUS DISCOVERIES AND INVENTIONS.

To the Editor of the Chemical News.

Sir,—The Committee on Science and the Arts of the Franklin Institute, of the State of Pennsylvania, respectfully requests that you will cause to be made known to the readers of your influential journal the fact that the Committee is empowered to award, or to recommend the award of, certain medals for meritorious discoveries and inventions, which tend to the progress of the arts and manufactures. These medals are:—

1. *The Elliott Cresson Medal* (Gold).—This medal was founded by the legacy of Elliott Cresson, of Philadelphia, and conveyed to Trustees of the Franklin Institute. By the Act of the Institution, May 17, 1849, the Committee on Science and the Arts was designated and empowered to award this medal, and the Committee decided to grant it, after proper investigation and report by sub-committee, either for some discovery in the arts and sciences, or for the invention or improvement of some useful machine, or for some new process, or combination of materials in manufactures, or for ingenuity, skill, or perfection in workmanship.

2. *The John Scott Legacy Premium and Metal* (Twenty Dollars and a Medal of Copper).—The John Scott Legacy Premium and Medal was founded, in 1816, by John Scott, a merchant of Edinburgh, Scotland, who bequeathed to the City of Philadephia a considerable sum of money, the interest of which should be devoted to rewarding ingenious men and women who make useful inventions. The premium is not to exceed twenty dollars, and the medal is to be of copper, and inscribed "*To the most deserving.*"

The control of the Scott Legacy Premium and Medal (by Act of 1869) was transferred to the Board of Directors of City Trusts, and referred by the Board to its Committee on Minor Trusts, and that committee resolved that it would receive favourably the name of any person whom

the Franklin Institute may from time to time report to the Committee on Minor Trusts as worthy to receive the Scott Legacy Premium and Medal.

The Franklin Institute, by resolution in 1882, accepted the above-named action of the Committee on Minor Trusts, and referred the duty of making such recommendations to the Committee on Science and the Arts. The Committee determined that the recommendation for such reward shall be made on the favourable report of a sub-committee, which shall be appointed to examine the invention or discovery.

The Committee requests your co-operation in facilitating the making of the aforesaid awards for meritorious discoveries and inventions, by bringing the facts herein set forth to the knowledge of your readers.

Upon request, therefore, from interested parties, made to the Secretary of the Franklin Institute, full information will be sent respecting the manner of making application for the investigation of inventions and discoveries; furthermore, the Committee on Science and the Arts will receive and give respectful consideration to reports upon discoveries and inventions which may be sent to it with the view of receiving one or the other of the awards herein named, and full directions as to the manner and form in which such communications should properly be made, will be sent on application.—By the Committee's order,

Wm. H. Wahl, *Secretary*.

The Franklin Institute of the State of Pennsylvania, for the Promotion of the Mechanic Arts, Philadelphia, Oct. 1, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 18, October 29, 1888.

The Telluric Spectrum at Elevated Stations, and in Particular the Spectrum of Oxygen.—M. Janssen.—The author ascended Mont Blanc in order to ascertain how the groups of dark lines produced by oxygen in the solar spectrum diminish in intensity with the elevation of the station, so as to elucidate the important question if these groups are entirely due to the oxygen contained in our atmosphere, or if the solar atmosphere takes a certain part in the phenomenon; in a word, if the solar light analysed before its entrance into the earth's atmosphere presents, or does not present, the bands and rays of oxygen. The author's object was merely to ascertain if the solar atmosphere contains this gas in a state in which it produces phenomena of absorption similar to those which the atmospheric oxygen occasions in light which traverses it. The groups A, B, and α of the solar spectrum have been ascribed to the presence of oxygen. They are situated in the less refrangible portion of the spectrum, in the orange and the red. But as the most important of the groups of watery vapour are found in the same region, to avoid confusion the author resolved to make his observations in very cold weather, a circumstance which, combined with the elevation of the station, would almost entirely eliminate the groups of watery vapour, and leave those due to oxygen distinct. He selected a hut situated at the Grands Mulets, on the ridge of Mont Blanc, at an elevation of 3000 metres. It was found that the rays and bands of watery vapour were entirely absent, as were also the oxygen bands in the red, the yellow, and the blue. The ray B and the neighbouring lines were much enfeebled, as was also the group α; A was scarcely visible. Hence the author infers that these groups would entirely disappear from the spectrum if it could be observed at the limits of the earth's atmosphere. Hence the rays and bands due to oxygen which we find in the spectrum are exclusively due to the earth's atmosphere. We are not, however, entitled to assume the absence of oxygen in the sun. We can merely say that oxygen does not exist in the sun's atmosphere in a condition capable of producing the spectral manifestations which it gives in the earth's atmosphere.

The Separation of Cobalt and Nickel by the Nitrite Method.—M. Baubigny.—The presence of lead and of the alkaline-earthy metals is an obstacle to the employment of the process for separating cobalt and nickel, founded upon the action of potassium nitrite.

The Chloro-derivatives of Acetyl-acetic Ether.—M. Genvresse.—This memoir is not adapted for useful abstraction.

Bulletin de la Société Chimique de Paris. Vol. l., No. 3, August 5, 1888.

First Attempts at the Synthesis of Seleniuretted Organic Compounds in the Aromatic Series.—M. Camille Chabrié.—Selenium tetrachloride exerts a chlorinising action upon the aromatic carbides (benzene and toluene). Selenious anhydride and selenyl chloride react upon benzene in presence of aluminium chloride. The action of fermentation is capable of reducing selenious acid.

Contributions to the History of the Isomerism of Fumaric and Maleic Acids.—T. Ossipoff.—This memoir does not admit of useful abstraction.

Action of Phenylhydrazine and Hydroxylamine upon Acetylacetone.—A. Combes.—By the reaction of phenylhydrazine upon acetylacetone the author has obtained a liquid boiling at 270·5° at normal pressure, and presenting exactly the composition of a dimethyl-phenyl-pyrazol.

The Hydrochlorates of Antimony Trichloride, Bismuth Trichloride, and Antimony Pentachloride.—R. Engel.—These compounds exist, and can be obtained as well-defined salts, easily capable of isolation. All three contain crystalline water, like all the other hydrochlorates of chlorides which have been obtained. In all there are at least 2 mols. of water to each mol. of hydrochloric acid fixed by the chloride.

On the Aspartic Acids.—R. Engel.—The fixation of the elements of ammonia upon the maleic and fumaric acids yields one and the same aspartic acid, which is optically inactive, and is capable of being split up.

Thermic Formation of the Salts of the Phenylen-diamines: Researches on Paraphenylen-diamine.—Leo Vignon.—The author has undertaken to measure the quantities of heat liberated by the union of certain acids with the three phenylen-diamines. The saturation of one of the basic functions of paraphenylen-diamine diminishes the intensity of the function, which remains free. Paraphenylen-diamine is a more powerful base than aniline.

Combination-heats of the Primary, Secondary, and Tertiary Aromatic Monamines with Acids.—Leo Vignon.—From his measurements the author deduces the conclusions that the quantities of heat evolved by the successive additions of one and then two mols. of hydrochloric and acetic acid and of one and then two semi-mols. of sulphuric acid give the measure of the relative formation heats of the salts produced, and permit us, at the same time, to appreciate their state of dissociation under the influence of the solvent. Thus, acetic acid and aniline can unite only very imperfectly in water. The want of stability of aniline acetate shows why it has not been obtained in the solid and crystalline condition.

The Composition of Natural Brandies and the Manner of Distinguishing them.—X. Roques.—

Chemical analysis enables us to render account of the spirits in consumption. There exists a decided difference between the results yielded by natural alcohols and the artificial kinds.

Influence of the Temperature of Fermentation on the Production of the Higher Alcohols.—L. Lindet.—At low temperatures there is a less production of the higher alcohols, but to an insignificant extent.

Determination of Fluorine in Substances Decomposable by Sulphuric Acid, especially in Phosphates.—H. Laine.—This paper requires the accompanying illustration.

An Apparatus for the Preparation of Sulphuretted Hydrogen.—P. Chantemille,—This paper also cannot be usefully reproduced without the illustration.

On Cupric Chloride Hydrochlorate.—Paul Sabatier.—The author's hydrochlorate is different from that of M. Engel. The latter produced a compound answering to the formula $CuCl_2HCl_3H_2O$. The hydrochlorate of M. Sabatier is $CuCl_22HCl_5H_2O$.

Preparation of Starch Paste as Indicator in Volumetric Analyses with Iodine.—M. Gastine.—The author grinds up together 5 grms. potato-starch and 1 centigrm. mercuric iodide. The whole is then stirred up in a little water, and the thin paste thus obtained is poured into a litre of boiling water. It is decanted after settling and the clear is preserved for use.

New Method for Detecting the Falsification of Pepper with Olive Kernels.—M. Gillet.—If to 1 grm. of olive-kernels we add 1 c.c. of tincture of iodine at 5 per cent the mixture takes a bright yellow colour in fifteen minutes, while the same quantity of pepper gives, with the same reagent, a brown or deep maroon. If we make up a series of type-mixtures containing 5, 10, 15, 20 per cent each of kernels, which mixtures, when once coloured, preserve their shade for years, we may easily ascertain the amount of the fraud. If the kernels exceed 20 per cent they can be seen with the naked eye.

MISCELLANEOUS.

Determination of Albumen in Urine.—Dr. H. Schauman.—The author proposes a modification of the gravimetric method for the determination of albumen in urine. Instead of the ordinary paper filter he uses a plug of cotton-wool freed from fatty matter, and pressed firmly into a glass tube drawn out to a narrow point. For this purpose a filter-tube is adapted, as introduced by Allihn for the determination of sugar. This tube, with its cotton plug, is dried at 110° and weighed. It is then fixed firmly, by means of a cork, in a filter support, which is then, in turn, connected with a filter-pump. The albumen in a weighed quantity of urine is precipitated in a beaker by the addition of a small quantity of acetic acid, and heating for half an hour on the water-bath. The clear supernatant liquid is first poured into the tube. The coagulum which adheres rather firmly to the bottom of the beaker is repeatedly washed with hot water, and the washings carefully poured upon the cotton before the precipitated albumen is introduced. This is then washed with hot water with the aid of the filter-pump, until the liquid running out no longer gives a chlorine reaction with silver nitrate. The tube is then closed at the wider end with a cork, perforated to admit a glass tube. It is then placed in a small rectangular drying box of sheet iron, provided on each of its two opposite sides with a circular aperture, into which the filter tube is inserted. The end having the perforated cork is connected with a calcium chloride tube and a washing-bottle charged with sulphuric acid, whilst the drawn-out end is connected with an aspirator. For an hour a moderately rapid stream of dried air is drawn though the filter-tube. The temperature in the drying box is gradually raised to 100°, and, after heating to this point for an hour, it is raised further to 110°, dried air being still drawn through in a moderately strong current. After heating for two hours at 110°, the tube is weighed and re-weighed every half hour, until the weight is constant.—*Zeitschrift fur Analytische Chemie*, Vol. xxvii., Part 5.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Cleansing Stone.—(Reply to J. R.).—Remove all dust with a soft brush. Then syringe carefully with rain-water (or distilled water). When dry apply a thin coating of the best Portland cement mixed with water (cement wash).—G. A. Keyworth, Hastings.

Waterproofing.—(Reply to Dr. Lorenz).—See short but useful article in "Cooley's Dictionary of Receipts" (Churchill, New Burlington Street, London). Large and valuable article in the "Encyclopædia Britannica" (Messrs. Black, publishers, Edinburgh, to whom apply).—G. A. Keyworth, Hastings.

MEETINGS FOR THE WEEK.

Saturday, 24th.—Physical, 3. "On the Measurement of the Luminosity of Coloured Surfaces," by Capt. Abney, F.R.S. "On the Suppressed Dimensions of Physical Quantities," by Prof. Rücker, F.R.S.

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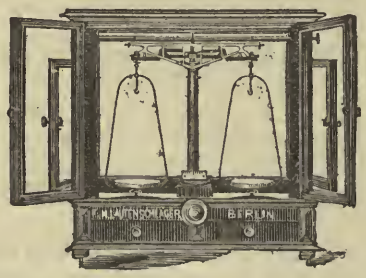

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1513.

ADULTERATION OF COAL-TAR NAPHTHA.

By THOMAS T. P. BRUCE WARREN.

In my previous communication (Chem. News, vol. lviii., p. 235) on this subject the word "low" in the second paragraph from bottom should be deleted, otherwise a wrong impression might arise. I give here a few numerical results on some ordinary commercial products to show the value of this method of testing:—

Designation of liquid.	I absorbed. Per cent.	Remarks.
Benzol, 90 per cent.. ..	1·911	
Toluol, commercial.. ..	4·046	Mean, 3·429 and 4·679 =4·054.
Naphtha, solvent	3·808	Sp. gr. 875 at 15·5° C.
„ product, 142° C.	3·429	Sp. gr. 869 at 15·5° C. 68 per cent.
„ „ 160° C.	4·679	Sp. gr. 870 at 15·5° C. 29 per cent.
„ „ residues	4·246	Sp. gr. 900 at 15·5° C. 3 per cent.
„ with 10% benzoline	5·742	
Benzoline	20·980	Sp. gr. 750 at 15·5° C.
Paraffin oil, white	4·864	Sp. gr. 797.
Shale spirit	44·900	

The iodine absorption of the original naphtha is 3·808 per cent, the absorption calculated on the products is 3·801 per cent. The addition of 10 per cent benzoline to the same naphtha should give a calculated absorption of 5·525 per cent.

The addition of petroleum products will evidently increase the iodine absorption. The sp. gr. of the mixture with 10 per cent benzoline was 863 at 15·5° C.

I hope to take an early opportunity of supplementing this list with the products from coal-tar and petroleum.

THE CATALYSIS OF POTASSIUM CHLORATE AND MANGANESE DIOXIDE.

By H. N. WARREN, Research Analyst.

Respecting the action of heat upon potassium chlorate, either alone or when aided by the addition of manganese dioxide, so well known is the decomposition that to attempt a more explicit explanation than is afforded by the numerous text-books of science would present a grave difficulty. But, as regards the addition of manganese dioxide, when we enumerate the various hypothetical reasons that are assigned to its use, and the replacement of the same by such absurd bodies as sand, &c., even by those who are supposed to hold high stations in the chemical profession, it can be readily understood that their general mode of reasoning must either be of an alchymetrical or of an extremely orthodoxal type. True, to speak definitely of such a reaction would be extremely precarious, owing chiefly to the unstability of the salt under question when exposed to an elevated temperature, and also to the peculiarity of the decomposition of the same, namely, the formation of a chloride, which in its turn either vigorously attacks, by the formation of secondary reactions, or totally destroys or contaminates the would-be products.

Evidently the surmise that manganese dioxide is attended by surface action, which is referred to by several authors, would, to any practitioner, be difficult to endorse, since the same portion, after separation by lixiviation, even to an indefinite number of times, is as active as in the first instance; but such cannot be said of surface actions in general, in which may be mentioned the case of finely-divided platinum, which speedily becomes impaired.

Although manganese dioxide is not the only substance that promotes the evolution of oxygen from potassium chlorate, yet, among those substances that are influential, all are observed to bear a similar ratio to one another; such, for instance, as cupric and plumbic oxide, an unstable sesquioxide of copper appears to exist. Oxide of copper has, therefore, a feeble affinity for oxygen, and though that affinity is not sufficiently adequate to retain the oxygen when separated from the potassium chlorate, it may undoubtedly aid in affecting its liberation. Sesquioxide of iron is also susceptible in the ferric acid of a higher but unstable stage of oxidation, and the same holds good of oxide of lead; hence their compounds facilitate the decomposition of the chlorate.

There is at present no proof of the existence of a higher oxide, either of zinc or of magnesia, and in accordance with the same, no perceptible effect is produced by the introduction of these compounds in place of manganese dioxide. This also would remove doubt why powdered glass and sand are as equally inert. It is also not improbable that during the decomposition of potassium chlorate, that minute traces of manganates may be produced, since the oxygen thus obtained is always contaminated with small quantities of free chlorine.

A somewhat striking experiment in favour of this may be performed as follows:—An intimate mixture of the two compounds is obtained and introduced into a wrought-iron tube, closed at one end, the further extremity being provided with a stop-cock or tap. The tube is now raised as rapidly as possible to a heat just below redness. Owing to the increased pressure exerted by the confined gas, the decomposition is much retarded. On a sudden liberation of the gas being allowed it naturally escapes with great violence, and invariably carries with it a large supply of chlorine gas. The contents of the tube also produce, on examination, proofs of distinct traces of free alkali.

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WAVE-LENGTHS OF METALLIC SPECTRA IN THE ULTRA VIOLET.*

By JOHN TROWBRIDGE and W. C. SABINE.

(Concluded from p. 239).

Effect of Change of Temperature of Source of Light on Constancy of Position of Metallic Lines.

In the process of the investigation we were much troubled by a slight shifting in position of the metallic lines upon the photographs. This shifting could be observed when the metallic lines were compared with a solar spectrum taken upon the same plate. The amount of this shifting in no case amounted to more than 0·1 or 0·2 of a wave-length. At first we thought it might be possible that there was a change in refrangibility of the metallic lines due to a difference in temperature of the source of light, and a long study was made of the influence of the temperature of the source of light upon its wave-length. When a metal was burned in the carbon electric light with varying strength of current no displacement could be observed between the lines of the metal photographed beneath each other upon the same sensitive plate. When the electric spark with a large battery of Leyden jars was substituted for the electric arc, and the metallic lines ob-

* Contributions from the Jefferson Physical Laboratory.

tained by the light of the spark were compared with those from the arc, occasionally a small displacement could be observed. This did not seem to arise from a change of position of the source of light, or from the heating of the slit of the spectroscope. A careful study of the iron lines showed us that the wave-length of the iron lines in the sun and those obtained from burning iron in the electric arc were the same to certainly one-hundredth of a wave-length. The displacement we observed was noticed only when the electric spark was employed. This shifting did not arise from a change of position of the spark in our apparatus, for it could not be produced at will by changing the position of the source of light. Moreover, when the arc light was placed in the same position that the spark occupied, no displacement could be observed in photographs taken by the aid of the arc. We were forced to conclude that through the range of temperature afforded by the electric arc and the electric spark, the wave-lengths of the metallic lines were constant. The displacement we observed was therefore referred to a jarring of the apparatus due to the noise of the electric spark. When the camera was at a considerable distance from the slit of the spectroscope, the displacement was diminished, and sometimes entirely disappeared. The entire apparatus was very solid, and the camera was clamped to a massive girder. It was difficult, therefore, to believe that the displacement could arise from the noise of the spark. We believe, however, that it can be ascribed to this cause, and that the wave-lengths of metallic lines produced by burning metals in the electric arc or by vaporisation in the electric spark, are to one-hundredth of a wave-length the same as those of the corresponding lines in the sun.

Results.

In the following table we have adopted the same symbols and letters to designate the character of the lines which the Committee of the British Association have employed. Column 1 refers to the intensity on a scale of 10. Column 2 gives our measures of the wave-lengths of the copper lines in the ultra violet from wave-length 2369·9 to 1944·1. Column 3 contains the measures of these lines by Hartley and Adeney. Column 4 are the corrections to be applied to Hartley and Adeney's results. Column 5 contains measurements by Liveing and Dewar. Column 6, corrections to be applied to their results. Column 7 gives the symbols adopted by the Committee of the British Association, which serve to describe the character of the line.

1. Intensity.	2. Wave-lengths of copper lines. Spark.	3. Hartley and Adeney.	4. Corr.	5. Liveing and Dewar. Arc.	6. Corr.	7. Intensity. B. A.
9	2369·9	2370·1	−0·2	—	—	9 br
1	2368·8	2368·7	+0·1	—	—	2 sd
—	—	2365·8	—	—	—	1
4	2356·7	2357·2	−0·5	—	—	5 sd
3	2355·2	2355·0	+0·2	—	—	2 sd
3	2348·8	2348·8	0	—	—	2 sd
1	2346·2	2346·2	0	—	—	2 sd
3	2336·3	2336·6	−0·3	—	—	3 sd
—	—	2303·8	—	—	—	1 sd
1	2299·6	2300·5	−0·9	—	—	1 sd
—	—	2297·5	—	—	—	1 sd
7	2294·4	2295·0	−0·6	2294·1	+0·3	6 sd
1	2293·9	2294·6	−0·7	—	—	3 sd
3	2291·1	2291·4	−0·3	—	—	3 sd
3	2286·7	2286·7	0	—	—	3 sd
2	2278·4	2279·6	−1·2	—	—	2 sd
6	2276·3	2277·0	−0·7	2276·0	+0·3	6 sd
2	2265·5	2265·8	−0·3	—	—	2 sd
2	2263·9	2263·9	0	2263·6	+0·3	3 nd
2	2263·2	2263·2	0	—	—	3 nd
2	2255·1	2257·7	−1·6	—	—	2 sd
2	2249·0	2250·0	−1·0	—	—	2 sd
7	2247·0	2248·2	−1·2	2246·6	+0·4	9 sd
—	—	2247·7	—	—	—	3 nd
7	2242·7	2244·0	−1·3	2242·2	+0·5	9 sd
—	—	2243·5	—	—	—	3 nd
1	2231·7	2233·0	−1·3	—	—	3 sd
1	2231·0	2332·2	−1·2	—	—	3 sd
3	2230·1	2231·2	−1·1	2229·6	+0·5	5 sd
3	2228·9	2230·0	−1·1	2228·3	+0·6	5 sd
2	2227·8	2229·1	−1·3	—	—	3 sd
1	2226·9	2228·1	−1·2	—	—	3 sd
1	2225·7	2227·0	−1·3	—	—	1 sd
1	2224·8	2226·0	−1·2	—	—	1 sd
6	2218·2	2219·3	−1·1	2217·5	+0·7	6 sd
—	—	2218·5	—	—	—	3 nd
2	2215·3	2216·5	−1·2	—	—	3 nd
1	2214·4	2215·8	−1·4	—	—	3 sd
2	2213·0	2214·1	−1·1	—	—	2 sd
6	2210·3	2211·3	−1·0	2209·7	+0·6	6 sd
—	—	2210·8	—	—	—	3 nd
—	—	2208·8	—	—	—	2 sd
2	2200·6	2200·3	+0·3	—	—	3 sd
3	2199·8	2199·8	0	2199·2	+0·6	1 nd
3	2196·9	2196·5	+0·4	—	—	3 sd
4	2192·4	2192·0	+0·4	2191·8	+0·6	6 sd
—	—	2191·2	—	—	—	3 nd
4	2189·9	2189·6	+0·3	2189·2	+0·7	6 sd
—	—	2188·5	—	—	—	3 nd
1	2181·8	2181·0	+0·8	—	—	1 sd
4	2179·5	2179·0	+0·5	2178·8	+0·7	5 sd
—	—	2178·0	—	—	—	3 nd
3	2175·2	2174·5	+0·7	—	—	3 sd
3	2149·2	2148·8	+0·4	2148·9	+0·3	3 sd
4	2136·1	2135·8	+0·3	2135·7	+0·4	3 sd
3	2134·6	2134·2	+0·4	—	—	2 nd
3	2126·2	2124·4	+1·8	—	—	3 sd
3	2125·3	2124·0	+1·3	—	—	2 nd
3	2123·1	2122·1	+1·0	—	—	3 sd
—	—	2121·5	—	—	—	2 nd
3	2117·5	2116·0	+1·5	—	—	1 sd
3	2112·2	2110·5	+1·7	—	—	1 sd
3	2104·9	2103·0	+1·9	—	—	1 sd
2	2098·6					
1	2093·9					
2	2088·1					
2	2085·5					
2	2078·8					
1	2067·0					
1	2062·7					
2	2055·1					
2	2045·0					
2	2037·3					
2	2036·0					
1	2030·9					
2	2025·7					
1	2016·9					
1	2015·8					
1	2013·2					
2	1999·9					
2	1989·4					
2	1979·4					
1	1970·4					
1	1944·1					

Conclusions.

It will be observed that the corrections to be applied to the wave-lengths obtained by Liveing and Dewar are progressive in their nature when compared with those which must be applied to the results of Hartley and Adeney. The difficulty in identifying lines and determining coincidences by employing the tables of metallic spectra in the ultra violet, published by the British Association, is illustrated by our work; for certain lines measured by Liveing and Dewar, which are identified by

the committee with lines given by Hartley and Adeney, are in reality removed from each other, one or two lines intervening. In certain cases the lines of Liveing and Dewar are wholly beyond identification with those given by Hartley and Adeney.

The results of our inquiry into the accuracy of the results of previous observers in measuring wave-lengths of metallic spectra in the ultra violet, can be summed up as follows:—

1. We believe that the method of photographing images of the slit upon the photographic plate due to Cornu in order to determine positions, leads to unavoidable errors.

2. The best method of determining wave-lengths of metallic spectra is by the use of concave gratings; for linear measurements are substituted for angular ones; underlying spectra are brought to the same focus as overlying spectra; and since a great number of lines are in focus on the same plate the conditions are the same for all, viz., breadth of slit, length of exposure, and source of light.

3. Hypotheses, in regard to coincidences of gaseous and metallic spectra, cannot be safely based upon existing measurements of spectra in the ultra violet.

4. The limit of the copper lines is extended by our investigation.—*Proceedings of the American Academy of Arts and Sciences.*

NOTE ON ERYTHROXYLON COCA GROWN IN INDIA.

By C. J. H. WARDEN, M.D., F.R.C.S.

Towards the latter part of last year Mr. R. Blechynden, Junior, Secretary to the Agricultural and Horticultural Society of India, asked me to undertake the analysis of certain samples of coca leaves grown in India, and the results of my examination are embodied in the following communication, which I venture to lay before that Society in the hope that it may prove of interest to its members.

There are, perhaps, few drugs which have in recent years attracted so much attention as the alkaloid cocaine, contained in the leaves of the *Erythroxylon coca.* Hitherto the chief sources of supply have been from Peru and Bolivia, where the plant is largely cultivated, and from Brazil and the Argentine Republic. As regards the cultivation of the coca plant in India in former years, I have no information to offer, but in connection with its cultivation in Ceylon, the following note occurs in an article by Dr. H. H. Rusby in the *Therapeutic Gazette* for January, 1887; he writes—"as regards the exportation of the culture of coca, the experiment has been tried, I believe, but once. Several years since Mr. F. L. Steinart, of La Pay, shipped a small quantity of seeds *viâ* London to Ceylon, and during the past season, the first products were shipped to London and sold at a high price." Again, in the *Pharmaceutical Journal** it is stated, "It would appear probable that a supply of coca leaves may be looked for from Ceylon, the *Erythroxylon coca* plant having been grown in the botanic gardens there for several years past. At present it forms straggling bushes with long weak branches, which is considered to be due to it having, up to the present, been cultivated mostly in the shade. But Dr. Trimen thinks that if the plant were brought out in the open and subjected to a periodical plucking of the leaves, it would doubtless soon put on a much more compact habit. It blossoms profusely several times a year, but does not yield much seed, as most of the yellow faintly scented flowers fail to set; but the plant can be readily grown from cuttings. It is worth mentioning that in Ceylon a closely allied species, *E. monogynum*† is common in the hot dry districts. The leaves of this species are said to be strikingly like those of *E. coca*, and they, before now, have been largely used for food by the poor in South India during famine, but it is not known whether they contain cocaine."

In 1885—6 the Agri-Horticultural Society distributed seedlings to the following tea-growing districts, and the samples of coca leaves received from these districts have formed the chief material with which I have worked:—Assam, Cachar, The Dooars, Darjeeling, Terai, and Jaunpore District.

In addition to the sources of supply indicated I have also examined samples grown at Ranchi, from seed obtained from Paris, and samples grown in the Society's gardens at Alipur.

In order to render my analytical results intelligible it will be necessary to first briefly describe the chemical properties of the constituents which have been described as being present in the leaves. In 1860 Nieman discovered the alkaloid cocaine. In 1862 Lossen isolated a second principle from the leaves, which he termed hygrin. The other principles, either present in the leaves or stated to be present, are amorphous cocaine, ecgonin, coca tannin, and a peculiar wax. Cocaine, the most important principle contained in the leaves, possesses all the properties of an alkaloid; it is crystalline, and forms crystallisable salts, of which the hydrochlorate is perhaps the most important. The alkaloid cocacine is only slightly soluble in water, but dissolves readily in alcohol or ether. The salts of cocaine, on the other hand, while soluble in water and alcohol, are practically insoluble in ether. The amount of alkaloid present in the leaves has been variously estimated at from traces to 0·8 per cent. When we come to consider hygrin and amorphous cocaine, the opinions of chemists who have worked at the subject appear to differ considerably. According to Stockman* hygrin exists in the leaves, while the so-called amorphous cocaine is merely a solution of ordinary crystalline cocaine in hygrin. Hygrin is described by Wöhler and by Lossen as a pale yellow volatile oily body, giving the ordinary reactions of alkaloids, hygroscopic, and forming hygroscopic salts, which crystallise with great difficulty. In opposition to this view regarding the nature of amorphous cocaine, the following remarks appeared in an editorial in the *Pharmaceutical Journal* for January 18th, 1887. "In reference to this subject we have recently received a letter from Dr. W. Merck, in which he states that his experience in working with cocaine does not agree with the opinion put forward by Dr. Stockman, and, as far as hygrin is concerned, he regards it as being a purely imaginary substance. When investigating the subject he considered it to be of especial importance to repeat Lossen's experiments with the view of obtaining hygrin, and ascertaining its properties and composition; but, as he states in his letter, all attempts to do so proved fruitless, and he could never obtain from coca leaves by distillation any product that could be regarded as an alkaloid. We are in a position to add that this has also been the experience of other operators, and it seems clear that, before Dr. Stockman's suggested explanation of the nature of amorphous cocacine can be accepted, the existence of hygrin must be established, and its capability of dissolving crystallisable cocaine demonstrated." In another editorial† on the coca alkaloids, the editor, referring to two contributions on the subject by Drs. Howard and Hesse, remarks that "both of them agree in confirming the fact that has already been pointed out in the *Journal* of the Association of an amorphous base with the true cocaine to which the production of local anæsthesia is referrible . . But it can scarcely be intented to dispute the existence of an amorphous base associated with cocaine in coca leaves,

* July 25th, 1885.

† I examined some leaves stated to be of this species obtained by Mr. Blechynden from a local druggist. The leaves were larger than coca leaves, and not in good condition. Treated in the same way as coca for extraction of alkaloid, they yielded 0·04 per cent of a principle which, however, did not possess the physiological properties of cocaine.

* *Journ Pharm. Soc.*, April 23rd, 1887

† *Pharm. Journ.* July 23rd, 1887.

in the crude cocaine imported from South America." Regarding the principle called ecgonine, there appears good evidence in favour of the view, that it does not exist ready formed in the leaves, but is a product of the decomposition of cocaine. The brief *resumé* I have given of the constituents of coca leaves indicates that the chemistry of the subject can hardly at present be considered as conclusive, and, as the editor of the *Pharmaceutical Journal* points out, "the increasing use of cocaine, not only as a local anæsthetic, but also for other purposes, and the very marked dissimilarity of many preparations of the alkaloid as met with in commerce, appear to require a somewhat more precise definition of its characters than has yet been given with any degree of authority. It is still an open question whether the amorphous substance, frequently associated with crystallisable cocaine and its salts, really possesses the anæsthetic property of the pure alkaloid, or if it does so, whether it does not at the same time produce other objectionable effects."

The method of assay adopted by me in my analyses of coca leaves was essentially the method recommended by Dr Squibb,* though in certain cases I varied the assay method in order to obtain control experiments. The process of assay first described by Dr. Squibb is stated to be based upon the process of manufacture, and is as follows:—

Take 50 grms. of the sample after having been powdered and passed through a sieve of 60 meshes to the linear inch, moisten the powder with an equal weight of alcohol of 92 per cent, to which has been added 1-60th of its weight of sulphuric acid, sp. gr. 1843. Allow the moistened powder to stand in a closed vessel for three or four hours, and then pack it firmly in a cylindrical percolator. Percolate with plain alcohol until 250 c.c. of percolate have been obtained. Evaporate the percolate in a shallow broad capsule at a low temperature until it is reduced to about 10 c.c., and then add to this 20 to 50 c.c. of water applied in two or three portions, carefully washing out all that is soluble in water from the clots of chlorophyll and resinous extractive matter. Filter the solution into a flask or separating apparatus, add to it an equal volume of ether, shake vigorously, separate the solution, and add half its volume of ether, and again separate the solution. Add to the aqueous solution an equal volume of ether, and then solution of carbonate of soda in excess. Separate the ethereal portion, put it into a tared beaker, wash the watery liquid with half its volume of ether, and add this ether to that contained in the beaker, and set this in a warm place until the ether is fully evaporated off. Then pour upon the residue in the beaker 5 c.c. water, rinse it round well without a stirrer, and having poured off the water, dry the contents of the beaker, and weigh and subtract the tare. The net weight is that of the crude alkaloid with much colouring matter. On an average a deduction of 20 to 25 per cent of the weight will give a close approximation to the cocaine contained in the sample. The alkaloids are left in the beaker in small varnish-like drops on the side, and a varnish-like film at the bottom, but in half an hour or an hour of drying, the drops generally become star-shaped crystals, and the film at the bottom also crystallises, but these crystals when touched are found to be sticky, and no amount of drying that the alkaloid will stand is of any avail to dry them further. The percolation of the leaves with acidulated alcohol decomposes the natural salt of cocaine which exists in the leaves, and the alkaloid is dissolved in the alcohol as sulphate of cocaine. After removal of the alcohol by evaporation, the ether dissolves the colouring matter, &c., present in the extract, but has no solvent action on the sulphate of cocaine, because, as has already been pointed out, salts of cocaine are insoluble in ether. The subsequent addition, however, of carbonate of soda decomposes the sulphate of cocaine with separation of cocaine, which is easily soluble in ether and is thus separated.

The method of assay I have described was subsequently modified by Dr. Squibb in several important particulars. In place of attempting to wash the alcoholic extract it is transferred to a bottle with acidulated water and agitated repeatedly with ether; in this manner all the chlorophyll and resinous extractive is separated, and from the aqueous solution the alkaloid is then separated by the addition of carbonate of soda, and repeated agitation with ether. The ethereal solution is then evaporated in a tared beaker, and the residue washed twice with 5 c.c. of distilled water, and after drying, weighed. This weight, according to Squibb, may generally be accepted as the proportion of crude alkaloid, and he states the results thus obtained appear to be a very close approximation to what the coca yields, but it does not yield as much to the manufacturing process by about 10 per cent, chiefly on account of the loss which occurs during the filtration through bone-black, and by splitting up; the bone-black being used on the manufacturing scale to free the alkaloid from traces of colour.

In all the samples of leaves examined by me I determined the percentage of moisture by exposing weighed portions over concentrated sulphuric acid in vacuo for several days. The ash was determined by igniting the amount used for estimation of moisture, at a temperature short of a red heat.

In Table No. I. I have tabulated the results obtained from the analysis of nine samples of Indian grown leaves, and for comparison I have included one analysis of a sample obtained for me by Mr. Blechynden from a local druggist's. This sample was an extremely poor one, the leaves were old and musty, and mixed with foreign leaves.

The variation in the amount of moisture present in the samples needs no special comments. As regards the ash yielded on incineration of the leaves, it was white, except in the second sample from Ranchi, in which it was of a decided reddish hue, from the presence of a marked amount of iron. Qualitatively, I was unable to determine any peculiarity about the composition of the ash; the ordinary mineral constituents of leaves were present. I thought, however, it might possibly be of interest to make quantitative determinations of certain salts, and in four samples of the leaves I determined the percentage of salts soluble and insoluble in water; the total amount of potash salts contained in that portion of the ash which was soluble in water, and the alkalinity of the soluble salts, expressed in terms of potash. In determining the amount of salts soluble in water, a weighed portion of the ash was mixed with distilled water, and a stream of carbonic acid passed through the mixture. The liquid was then evaporated to dryness and gently heated. The soluble salts were then extracted with water. A small measured volume of the solution was evaporated to dryness for estimation of dissolved salts, and this portion also served for estimation of free alkali, while the bulk of the solution was used for estimation of the total potash salts by means of platinic chloride. The results are shown in Table No. II.

Taking the total ash contents of the leaves calculated on the anhydrous leaves, and comparing the results with the percentage of alkaloid calculated in a similar manner, it would appear that in many of the samples examined the percentage of alkaloid is inversely proportional to the ash; but in the case of the sample from the Matelli tea gardens, a large percentage of ash is associated with a high percentage of alkaloid. (See Table No. III.).

The apparent effects of locality and methods of cultivation on the ash and alkaloid contents of the samples will be considered later.

In estimating the alkaloid contained in coca leaves by the process first suggested by Squibb, I found it impossible to thoroughly wash the alcoholic extract with even the maximum volume of water directed to be used, and the

* *Ephemeris*, January and May, 1885.

Table No. I.

District in which sample was grown.	Moisture, per cent.	Ash, per cent.	Crude alkaloid.	Crude alkaloid calculated on anhydrous leaves.	Remarks.
Ranchi, young leaves..	6·18	6·30	1·069	1·139	Leaves sound.
,, mature leaves..	8·22	8·25	0·811	0·883	,, ,,
Arcuttipore, Cachar, 1st sample	6·08	6·97	1·286	1·369	,, ,,
,, ,, 2nd ,, ...	6·72	5·94	1·56	1·671	,, ,,
Central Terai Tea Co., Darjeeling	10·37	6·80	1·09	1·115	,, ,,
Agri-Hort. Soc. Gardens, Alipore, Cal...	10·42	9·17	0·322	0·358	,, ,,
Matelli Tea Company	9·30	11·05	0·938	1·022	,, ,,
Chulsa, Julpaguri Dooars..	5·71	7·14	0·576	0·610	,, ,,
Jaunpore District	10·05	11·37	0·515	0·571	,, ,,
Leaves from Druggist's in Calcutta, source unknown	13·34	9·77	0·045	0·051	Old, musty: foreign leaves present.

Table No. II.

Source of sample.	Percentage of salts soluble in water, calculated on ash.	Percentage of salts insoluble in water, calculated on ash.	Total potash salts calculated as KHO, calculated on ash.	Percentage of total potash salts calculated as KHO in salts soluble in water.	Alkalinity of salts soluble in water calculated as potash KHO on ash.
Central Terai Tea Co., Darjeeling	44·42	55·58	29·26	65·64	8·33
Society's Gardens, Calcutta	34·60	65·40	19·13	55·28	5·53
Arcuttipore, Cachar..	59·02	40·98	29·84	50·56	8·49
Matelli	64·17	35·83	31·36	48·87	12·95

Table No. III.

Source.	Per cent of ash on anhydrous leaves.	Per cent of alkaloid on anhydrous leaves.
Ranchi, young leaves ..	6·71	1·139
,, mature ,, ..	8·99	0·883
Arcuttipore	7·39	1·369
,, ...	6·36	1·671
Central Terai Tea Co. ..	7·58	1·115
Society's Gardens	10·23	0·358
Matelli	12·18	1·022
Chulsa, Dooars	7·62	0·610
Jaunpore	12·64	0·571

Table No. IV.

Source of leaves.	Method of curing the leaves.
Ranchi	Withered 24 hours in Tea house and then dried off quickly in the sun, on zinc trays.
Arcuttipore, Cachar..	Leaves collected twice a month since May last, first withered in shade, in the same way as tea leaf. Then gently rolled by hand for a few minutes, and immediately placed in a tea dryer at a temperature of 150° F. In about 10 minutes they are quite dry and retain their green colour.
Central Terai Tea Co., Darjeeling.	Picked in July, and dried over tea charcoal chulas at about 260° F.
Agri.-Hort Society Gardens, Calcutta.	Picked daily for about 10 days, dried in a room.
Matelli Tea Co.. ..	Picked in July, and dried in a basket dhool over charcoal at about 200° F.
Chulsa, Jalpaiguri ..	Leaf collected in October, and dried in an airy room.
Jaunpore District ..	Dried in the shade.

modified method of assay was adopted. The crude alkaloid obtained by me was only very faintly yellowish in colour, and was certainly not contaminated to any extent with colouring matter. But while no exception could be taken to the colour of the ethereal extract, it differed in one very marked particular from the crude alkaloid extracts described by Squibb, for in no single instance did the extract show any tendency to spontaneous crystallisation. The fact that certain samples of leaves fail to yield a crystallisable alkaloid has been noticed before, and has been attributed to the method of curing, or age of the leaves, or to the presence of amorphous alkaloid. Dr. Paul, in a paper, "Notes on Cocaine and its Salts"* points to the fact that by mere evaporation of a solution of cocaine in water, the whole, or nearly the whole, of the alkaloid is converted into another substance, and he remarks that in the absence of any knowledge as to the state in which cocaine exists in coca leaves, it would be premature to offer any decided opinion, but if the alkaloid exists in the leaves in a free state, the fact of its being susceptible of decomposition by merely warming with water would point to the necessity of especial care being taken in the curing and preservation of coca leaves. Any degree of heating while the leaves are in a moist condition would probably exercise a damaging influence and determine the destruction of the alkaloid. It has been observed that there is a very great variation in the amount of cocaine to be obtained from different parcels of coca leaves; it may be well worth taking some trouble to ascertain whether this variation is not referrible to the mode of collecting and drying the leaves for transport. The method of curing the samples which form the subject of this communication is given in Table No. IV.

(To be continued).

On Tin.—Leo Vignon.—Tin, which has been precipitated by means of zinc from neutral solutions of stannous and stannic chlorides, is very readily oxidised. If exposed to the air for three or four days, it contains a quantity of hydrated stannous oxide, equal to the fourth or third of its weight. A relatively small quantity of stannous oxide mixed with metallic tin renders it infusible. If tin partially oxidised is heated in contact with the air, it burns without fusing. In a current of an inert gas globules of tin form and remain isolated without coalescing into a regulus. This phenomenon is analogous to that presented by mercury, which remains sub-divided in presence of certain impurities.—*Comp. Rend.*, No. 19.

* *Jour. Pharm. Society*, October 17, 1885.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending October 31st, 1888.

By WILLIAM CROOKES, F.R.S.;
WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To General A. De Courcy Scott, R.A., *Water Examiner, Metropolis Water Act*, 1871.

London, November 6th, 1888.

Sir,—We submit herewith the results of our analyses of the 189 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from October 1st to October 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

The high quality of the water referred to in September's report has been well maintained during the past month. Moreover, the analysis of the daily samples are marked by great uniformity of excellence. Thus of the Thames-derived waters only 4 out of 130 samples examined by the oxygen process required more than 0·045 grain of oxygen per gallon to oxidise the organic matter, the average of the whole 130 samples being a little over 0·03 grain per gallon.

Of the 189 samples examined, 187 were clear, bright, and well filtered.

We are, Sir,
Your obedient Servants,
William Crookes.
William Odling.
C. Meymott Tidy.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

November 10, 1888.

Prof. Reinold, President, in the chair.

The following communications were read:—

"*On the Calculation of the Coefficient of Mutual Induction of a Helix and Coaxal Circle.*" By Prof. J. V. Jones.

In arranging some experiments for determining resistance absolutely by Lorenz's method, the author had occasion to consider what form of standard coil was most suitable for accurate calculation, and chose a helix of large diameter with a single layer of wire. To obtain a sufficient number of turns, requires considerable axial length; and Lord Rayleigh's approximate method of calculating the coefficient was found to be insufficient where an accuracy of 100-per cent is required.

A method of calculation is given considering the wire as a helix whose equations are—$y' = A \cos \theta'$, $z' = A \sin \theta'$, and $x' = k\theta$; those of the circle being $y = a \cos \theta$ and $z = a \sin \theta$.

The general expression for M, viz.—

$$\iint \frac{\cos e}{r} ds\, ds',$$

when applied to this case becomes—

$$\int_0^{2\pi}\int_0^{\vartheta} \frac{Aa \cos(\theta-\theta')\, d\theta\, d\theta'}{\sqrt{A^2+a^2-2Aa\cos(\theta-\theta')+k^2\theta'^2}}$$

One integration is perfomed by change of variables, making $\theta-\theta'=\phi'$ and $\theta'=\phi$. When θ is an integral multiple of π (say n) the integral is expressible in terms of a series involving the complete elliptic integrals E and F of modulus—

$$c = \frac{2\sqrt{Aa}}{A+a}$$

the expression for M being—

$$M = 4n\pi \frac{Aa}{A+a} \Sigma(-1)^m \frac{1.3\ldots 2m-1}{2.4\ldots 2m} \frac{1}{2m+1}\left(\frac{x}{A+a}\right)^{2m} P_m,$$

where $x = kn\pi$ and $P_m = \int_0^{\frac{\pi}{2}} \frac{\cos 2\theta\, d\theta}{(1-c^2\sin^2\theta)^{\frac{2m+1}{2}}}$

If—

$$Q_m = \int_0^{\frac{\pi}{2}} \frac{d\vartheta}{(1-c^2\sin^2\vartheta)^{\frac{2m+1}{2}}}$$

then—

$$P_m = \left(1-\frac{2}{c^2}\right)Q_m + \frac{2}{c^2}\, Q_{m-1} \quad . \quad . \quad (B).$$

$$\text{and} \quad Q_m = Q_{m-1} + \frac{c}{2m-1}\frac{d}{dc}\, Q_{m-1} \quad . \quad . \quad (C).$$

Observing that $Q_0 = F_{(c)}$ and $Q_{-1} = E_{(c)}$, P_1, P_2, &c., may be expressed in terms of $E_{(c)}$, $F_{(c)}$ and c.

Instead of calculating each term P_m independently, it is found easier in practice to deduce successive values from equations (B) and (C), combined with $(1-c^2)Q_1 = E$ and its derivatives. Applying the formula to a circle of 10 inches diameter, placed concentric with a helix of 20 inches diameter and 4 inches long, the value obtained is $M = n.\ 53{\cdot}259$, whereas Lord Rayleigh's formula gives $n.\ 53{\cdot}317$.

Prof. Perry asked if the thickness of the wire had been considered, and whether the author could give any information as to practical working formulæ for the mutual induction between two ordinary cylindrical coils in any position.

Dr. Fleming described a wooden anchor ring wound like a gramme armature, and having a secondary coil added, which he had devised as a standard of mutual induction, and used for determining capacity absolutely.

In reply the author said he had not considered the wire to have thickness, as he felt sure this would not affect the result for his coil by one part in 100,000. With respect to Dr. Fleming's anchor ring, he considered the difficulty of winding it sufficiently uniformly, to be a great drawback to its general adoption.

"*On the Upper Limit of Refraction in Selenium and Bromine.*" By Rev. T. Pelham Dale, M.A.; read by Mr. Baily.

In a former paper (read Feb. 11, 1888) the author showed that an upper limit of refraction for selenium should theoretically exist about the middle of the visible spectrum, and the present communication describes some experiments which tend to confirm the prediction. On placing a thin film of selenium under a spectro-microscope, it was found to be opaque to rays above the

green, and previous calculation had given 5395·7 as the limiting wave-length transmissible.

Sulphur, at ordinary temperature, should have its upper limit beyond the visible spectrum, but theory indicates that increased temperature will lower the limit. It is well known that sulphur darkens when heated, and when a film of boiling sulphur was examined under the spectro-microscope, all but the red end of the spectrum was absorbed. On cooling, the region of absorption gradually retreated towards the violet end.

Selenium is also found to become more transparent as it is cooled, and its refractive equivalent is equal to that of sulphur, multiplied by the ratio of its chemical equivalent to its density. Important optical as well as chemical relations thus exist between the two elements.

The results obtained by bromine films were remarkably similar to those of selenium, the violet rays being entirely cut off.

A method of solving the equation $a \sin \theta = \sin m \theta$ (on the limiting solution of which the upper limit of refraction depends) by a table of Eulerian integrals, is given in the paper, and an analogy between total reflection and the upper limit of refraction is traced.

"*Experiments on Glass in Polarised Light.*" By Prof. S. P. Thompson, D.Sc.

Irregular pieces of glass can be tested for internal strain by immersing them in a liquid of equal refractive power. Various specimens of tubing, rod, and thermometer tubes were examined in this way, all of which showed defective annealing. One piece of ordinary rod bent zigzag produced remarkable effects when rotated in the liquid. Prince Rupert's drops, a glass wedge, and a model of the "Regency Diamond" showed vivid colours, and the stems of broken incandescent lamps exhibited various degrees of annealing.

Mr. Hilger wished to know whether paralled plates had been tested, and with what result; for he had always found pieces of shapes approaching to roundness to show greater defects than parallel plates. For this reason he always cut his prisms and lenses from rectangular blocks.

Mr. Blakesley said that no perfectly annealed thermometer had been shown, and he was anxious to know whether any existed.

Mr. Wilson expressed a doubt as to whether it was possible to anneal anything, so as to be perfectly free from internal strain, and thought the act of breaking rods and tubes necessarily introduces strains.

Prof. Rücker asked whether the usual method of detaching a mercury column for calibrating thermometers produced any injurious effect, but the author was unable to speak decisively on the subject.

In answer to the President, Dr. Thompson said the liquid used was a mixture of carbon bisulphide and alcohol. His experience with parallel plates coincided with that of Mr. Hilger. As an example of the remarkable effects which could be produced on glass by various methods of cooling he directed attention to the fact that Prof. Exner, of Vienna, had produced lenses having plane faces.

"*On a New Form of Standard Resistance Coil.*" By Dr. J. A. Fleming, M.A.

Considerable difficulty has been experienced with coils of the ordinary B.A. construction when immersed in water or melting ice, due to leakage across the paraffin-wax can, caused by condensation of moisture. To overcome this, various forms have been tried, and the best yet yet devised is made by winding the coil in the space between two shallow annular casings, screwed together by projecting flanges. The joint is formed by indiarubber, and can be tested for leakage by immersing in water and applying air pressure through a small testing tube. The rising part of the terminal rods are enclosed in long brass tubes soldered to the upper casing, and are insulated by air, excepting at the top and bottom, where ebonite rings are placed. The top ring forms a corrugated cap, and an annular channel in its upper surface serves as a fluid insulator. The wire, which is triple silk covered, is baked for some hours at a temperature above 100° C., and then soaked in anhydrous paraffin-wax containing about three per cent of resin.

NOTICES OF BOOKS.

Laboratory Manual of General Chemistry: Including Directions for Performing One Hundred of the More Important Experiments in General Chemistry and Metal Analysis, with Blanks and a Model for the same, Laboratory Rules and Suggestions, and Tables of Elements, Compounds, Solutions, Apparatus, and Chemicals. Prepared for Use with any Text-book of Chemistry, specially adapted to accompany "Introduction to Chemical Science." By R. P. Williams, A.M. Boston: Ginn and Co.

The author of this book, without aiming at conciseness, is scarcely master of the art of expressing himself clearly in the fewest possible words. Thus, in the "Rules and Suggestions for the Laboratory," he writes:—"Never put down a stopper when using a reagent bottle, but hold it between the first and second fingers, and replace it *as soon as you are through using it.*" How much more simple would it have been to say, instead of the eight words we have italicised, "when done with"!

The 10th rule does not seem intelligible. It reads:—"Pour only liquids or fine powders into the bowls, always opening the jet at first to let the water run." No "bowls" or "jets" have been mentioned as among the apparatus required. In one of the experiments the student is told to "touch a drop of the filtrate to the tongue." Here space would have been saved by writing "taste a drop of the filtrate." Speaking of sulphurous acid, we find the direction "cautiously take the odour." Why not "smell cautiously?" These defects may seem trifling, but when an author in pursuit of brevity uses symbols and abbreviations to an unpleasant extent, it seems strange that he should not use the most concise expressions consistent with clearness.

The experiments, for the most part, are well selected, and the rules for their performance are generally judicious. We can scarcely say as much for the 1st, 2nd, and 3rd experiments, relating to length, volume, and weight. The power of guessing linear dimensions correctly is of much more use to the physicist than to the chemist. Making a drawing of a glass measure, or, as the author calls it, a "graduate," and of a cube 1 c.m. on a side, are also curious laboratory experiments. Instructions in the art of weighing are very essential for the student. But, instead of attending to the most needful points, he is told, *e.g.*, to see if 1 grm. (of salt) can be piled on a one-cent coin, to experiment with 5 grms. in like manner, and lastly to make drawings of 1, 5, and 10 grm. weights.

The Metallurgy of Gold: A Practical Treatise on the Metallurgical Treatment of Gold-bearing Ores, including the Processes of Concentration and Chlorination, and the Assaying, Melting, and Refining of Gold. By M. Eissler, Mining Engineer and Metallurgical Chemist. Formerly Assistant Assayer of the U.S. Mint, San Francisco. London: Crosby Lockwood and Son.

The author opens his subject with an account of the mining operations in California after the exhaustion of the placer diggings and the introduction of quartz-crushing. The method first adopted was simple and inefficient. The quartz was taken out of the mine, pulverised, and the gold extracted by amalgamation on copper plates. Much of the gold hereby went to waste, being washed away. As the lodes were worked to a greater depth the difficulties increased, as the gold

diffused through the quartz was no longer in a "free" state, but entangled. The ores capable of treatment by amalgamation alone are generally contained in that portion of a gold-bearing lode which lies above the water-line. From such portions the rebellious elements have been oxidised and leached out by the alternating action of air and water, leaving the gold free and clean. Below the water-line the gold is entangled in sulphurets incapable of successful amalgamation. The method at present in use for such material involves concentration for the removal of the useless matter, the amalgamation of the free gold, and the extraction of the rest by chlorination.

There is still, however, much room for improvement. The author informs us that not more than half the gold in the quartz is secured. The actual loss, alike in California and Australia, is at least 40 per cent. One of the oldest and best authorities in California states that in his operations gold has been taken up so fine that in distilled water at rest it would not subside in less than from five to ten minutes. In an actual average of seven years' work in Colorado, the assay value of the ore was £7 18s. per ton, while the average value per ton extracted was only about £3.

The total gold production of the State of California since 1848 has been above £250,000,000, but it is estimated that a still larger quantity has been wasted in milling and hydraulic mining. According to the researches of Dumas, gold exists in iron and copper pyrites partly as a double sulphide. The occurrence of gold in limestone has been recorded only once.

After describing at great length the operations of milling and amalgamation, and pointing out the conditions, the author refers to the observations and experiments of Prof. Skey as throwing a light upon the difficulty experienced in extracting gold by amalgamation. Sulphuretted hydrogen renders gold non-amalgamable. Hence Skey concludes that the natural surfaces of native gold are covered with a thin film of gold sulphide.

The process of chlorination, with all the necessary appliances, are described in full with the aid of the necessary illustrations.

The two remaining chapters discuss the melting, refining, and assaying of gold, and the chemical examination of gold ores.

We can strongly recommend this work to all persons who are directly or indirectly interested in gold-mining and its kindred operations.

Handy Book of Medicine Stamp Duty, with the Statutes and Appendices. By E. N. Alpe, of the Middle Temple and the Inland Revenue Department, Somerset House. London: Offices of the *Chemist and Druggist.*

If it be true, as we doubt not, that the intellectual education of any nation or any class is inversely as the demand for patent, quack, or "proprietary" medicines, Britain has little to boast of, and further, we do not seem to be improving. The work before us probably owes its existence to recent misunderstandings which occur between pharmaceutists and the Inland Revenue Department. The former complain that the law and the practice on this subject are obscure, and admit sometimes of arbitrary interpretation. The Revenue officials seem to think, on the contrary, that the rules governing the administration of this branch of the law are very simple and comprehensible. Hence the publication of this book should do good service.

The subject, however, is eminently unpleasant. The fulsome advertisements which we encounter on the walls, in public conveyances, and in the press—especially in religious journals—are a painful proof of public gullibility. How is it that our Chancellors of the Exchequer do not levy a heavier contribution upon a business at once so lucrative and so inimical to the public well-being? A list is given of the persons who hold or have held patents for quack medicines. It is worthy of note that some of the most diligent advertisers do not figure in the list.

Chemical Laboratory Labels. Compiled by H. H. Symons, F.R.M.S., F.C.S., F.I.C., &c. Idris and Co., Kentish Town.

These labels are printed in a good bold type, and the eye is not distracted by the presence of formulæ and molecular weights. For those who want such data to appear on their reagent labels, they are printed separately and may be subjoined. The names adopted will, to many chemists, have an unfamiliar sound. The acids have disappeared, and have become hydrogen chloride, hydrogen bromide, &c.

Handbook of Sydney for the Use of the Members of the Australian Association for the Advancement of Science. Edited by W. M. Hamlet, F.I.C., F.C.S., Government Analyst. Sydney Meeting, 1888. Sydney: Turner and Henderson.

This little handbook contains, besides an introduction from the pen of the editor, chapters on the climate, by the Goverment Astronomer, H. C. Russell, F.R.S.; on the geology of the district, by C. S. Wilkinson, F.G.S.; on the local botany, by J. H. Maiden, F.L.S., of the Technological Museum; an account of the mammals, by Dr. G. Bennett, F.Z.S.; the marine fauna, by Dr. W. A. Haswell, F.L.S., of the University of Sydney; the insects, by A. Sydney Oliff, F.E.S., of the Australian Museum; the mollusks, by Dr. J. C. Cox, F.L.S.; commerce and industries, by C. Lyne; and an itinerary, by the editor.

The birds and fishes, or rather the sections describing them, have, the editor informs us, disappeared without any fault of his own.

The mean annual temperature, as Prof. Russell informs us, is only 62° 6′, which does not exceed the mean of Toulon and Barcelona. But while Barcelona has a summer temperature of 76·1°, and Toulon of 75·2, that of Sydney is only 71·1°. In return, the winter temperature of Sydney is 54°, against 50° at Barcelona and 48·5 at Toulon.

The list of excursions is tempting in its variety. One of those suggested is a trip to the Sydney Sewage Farm at Shea's Creek. It is scarcely needful to say that in the dry climate of Australia sewage-irrigation must be very much more appropriate than in Britain.

The Annual Report of the Public Analyst appointed for the Parish of St. George, Hanover Square, upon the Articles Analysed during the Year ended March 25, 1888. By Charles E. Cassal, F.I.C., F.C.S., Public Analyst.

The articles which have been analysed include 47 samples of dairy produce, 36 of condiments, 32 of cereals and farinaceous matters, 24 of tea and coffee, and 12 of sugar, forming a total of 151. Of these, 116 were genuine, 21 adulterated, and 14 of inferior quality, but which could not be decisively called adulterated. On comparing these results results with those obtained in the previous year, 1886—87, we see a distinct improvement, the genuine samples having risen from 61·9 to 76·82 per cent, the adulterated falling from 20·4 to 13·91 per cent, and the inferior from 17·7 to 8·61.

The samples of milk, if taken separately, show an improvement. The "genuine" samples have increased from 20·8 to 47·06 per cent, the adulterated simultaneously decreasing from 58·4 to 29·41 per cent. The inferior samples, however, remain substantially at the same point, being 20·59 per cent as against 20·8 per cent in the previous season. Mr. Cassal also remarks that many of the samples which had to be regarded as genuine were by no means of the best quality. It seems evident that milk-dealers are learning how to keep within the letter of the

law, and skim or water their milks down to the limit of safety. Legal proceedings were taken in seven cases. One of the offenders escaped under the plea of "warranty." The fines inflicted in the other six cases amounted only to a total of £8 10s., or less than 30s. each, a sum quite insufficient to deter from future dishonesty.

The Annual Report of the Public Analyst Appointed for the Parish of Kensington upon the Articles Analysed during the Year ended 31st March, 1888. By Charles E. Cassal, F.I.C., F.C.S., Public Analyst.

During the year in question 503 samples have been submitted for analysis by the Inspectors under the Act. Of these 229, or nearly one-half, were milk, 47 butter, and 28 coffee. On comparing the year's results with those of the two former years, we find the articles pronounced genuine rising progressively from 48·7 to 53·0 and 72·2. The adulterated samples have fallen from 34·5 to 28·0, and finally to 15·3 per cent. The "inferior" articles, on the contrary, show no such improvement. In 1885-86 they were 11·1 per cent, in 1886-87 17 per cent, and in 1887-88 again 11·1 per cent.

Milk was, as usual, the worst article. Of the 229 samples examined 62 were adulterated, in many instances grossly so, in addition to 33 pronounced inferior and 7 abnormal. Even here, however, there is steady improvement. The samples of milk other than genuine and normal amounted in 1885-86 to 71·0 per cent, in 1886-87 to 62·14 per cent, and in 1887-88 only to 44·54 per cent. Small amounts of boracic acid were detected in seven samples, and not a few of the samples are rightfully pronounced "dirty," containing mineral and vegetable débris and epithelial scales.

Coffee still retains that bad position which it owes to the late Sir C. Wood, who, from whatever motive, when Chancellor of the Exchequer, first legalised the sale of chicory in admixture with coffee. It is much to be regretted that the Sale of Food and Drugs Act still allows highly chicorised mixtures to be sold without the usual label under the mendacious names "Coffee as in France," &c.

Mr. Cassal calls attention to a defect in the "Margarine Act." Salt or *other preservative and colouring matter* may be added without any limitation either as to their quantity or quality.

It is to be further regretted that magistrates not uncommonly grant applications for adjournment in case of perishable articles. It is very desirable that the importation and sale of substances used for adulteration and not having any legitimate application should be interdicted. As an instance we may mention olive stones, whole or ground.

CORRESPONDENCE.

WARNING TO CHEMISTS.

To the Editor of the Chemical News.

Sir,—Shortly after the appearance of your lettters of warning, published on the 13th and 20th of January last (Chem. News, vol. lvii., pp. 23 and 30), I had an opportunity of seeing the German impostor therein described. Between then and now many of my friends have been victimised, but not yet myself. Some of us are familiar with his personal appearance from the fact of his not keeping a good account of the places or persons upon whom he has called, and we notice that he is continually changing his name, sometimes even two or three times a day. Just lately he is again busy at his tricks, having netted several pounds from unsuspecting sympathisers of my acquaintance in London, who were ready to help him on his way back to Germany, where he never goes.

Another tale is that he is awaiting remittances from his own country to enable him to proceed to Huddersfield, where he has promise of an appointment; but as he repeats the self-same story at long intervals of time, the fact of imposture is perfectly clear. His last and latest scheme is to approach the London members of the Zurich and German Chemical Societies, producing the printed lists of membership to help his enquiries, and telling off one chemist against another as having aided him in his (temporary) difficulties.

Your second writer, "Analyst, F.I.C., &c.," says he began his tricks in Scotland in the summer of 1887, and concludes his letter by expressing "the hope that this correspondenee will warn others, and enable them to *hand him over to the police*." This may now be done, for there is a Bow Street warrant out against him. Fifteen months is a long time for a suffering profession to put up with the barefaced rascality of this young Teuton. Age about 27, height 5 ft. 9 in., slim figure, slight moustache, no beard; hair rather dark and parted near the middle; wart on forehead, above the left eye; for breast-pin he sometimes wears a cheap imitation of a 20-mark piece. He claims to be a Ph.D.; speaks English with a decidedly German accent; respectable in appearance, with black cloth overcoat and round-shaped felt hat. Generally a chemist, but has been known to pose as an engineer.—I am, &c.,

Another F.I.C.

London, November 19, 1888.

SULPHUR IN IRON.

To the Editor of the Chemical News.

Sir,—In reply to Mr. L. Speyer's criticism on my note entitled "The Dissolution of Sulphur and Phosphorus" (Chem. News, vol. lviii., p. 177), I would state, in the first place, that Mr. Speyers is evidently unfamiliar with electro-dissolution, and at once condemns it, as he states, as being plausible, although he does not even state whether he has ever performed such an experiment. Secondly, his statement with respect to the liberation of sulphur is incorrect. It is true that by acting on a saturated sulphide, by the aid of a powerful electric current, sulphur may be liberated, but exactly a reverse action is observed when iron containing only small quantities of sulphur is operated upon.—I am. &c.,

H. N. Warren.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 19, November 5, 1888.

The Occlusion of Gases in the Electrolysis of Copper Sulphate.—A. Soret. — The author finds that electrolytic copper always contains a certain quantity of gas, consisting almost exclusively of hydrogen. It retains a little carbonic acid and a very small quantity of carbon monoxide. There exists a certain relation between the quantities of occluded gas and the conditions of temperature and acidity at which the deposit has been obtained, conditions which are again related to the malleability of the metal. This internal gaseous atmosphere is consequently variable, and the quantity of 4·4 vols., found by Lenz, holds good for merely the particular conditions of his experiments. This number corresponds to a very brittle deposit, and is one of the highest observed. The

hydrogen is never combined with the copper, but merely occluded.

On Homo-pterocarpine and Pterocarpine obtained from Santal Wood.—P. Cazeneuve and L. Hugounenq.—The authors adopt to these two compounds the respective formulæ $C_{24}H_{24}O_6$ and $C_{20}H_{16}O_6$.

On a Body, at once Acid and Base, contained in Cod-liver Oil (Morrhuic Acid).—Arm. Gautier and L. Mourgues.—The compound in question has the composition $C_9H_{13}NO_3$, and differs from tyrosine merely by containing two more H. The acid exists in the oils in the form of a complex and unstable body, behaving like the ordinary lecithines, being decomposed if heated in presence of acids or alkalies, liberating glycerin, phosphoric acid, and a complex acid. It belongs to the pyridic series.

On Yaraque, a Fermented Drink used by the Savage Tribes of the Upper Orinoco.—V. Marcano.—The basis of this preparation is cassava. The fact of a mould whose spores act as an alcoholic ferment, though exceptional in temperate climates, appears very general under the tropics.

Study on the Analysis of Brewer's Yeast.—M. Martinand.—The quantity of maltose left untouched after six days at 25° by *Saccharomyces ellipsoideus* differs so widely from that left by *S. cerevisiæ* that these two ferments cannot be confounded.

Zeitschrift fur Analytische Chemie.
Vol. xxvii., Part 5.

What is the Value of the Recent Quinine Tests? Experiments towards a Fundamental Treatment of the Question.—W. Lenz.—This voluminous treatise does not admit of abstraction.

Action of Hydrogen Sulphide upon Arsenic Acid.—Le Roy W. McCay.—If a slow current of sulphuretted hydrogen is passed into the solution of an alkaline arseniate, acidulated with sulphuric or hydrochloric acid, and heated to 70°, there is formed, along with some pentasulphide, a larger or smaller quantity of free sulphoxyarsenic acid, which, under the influence of the strong mineral acid, is split up into arsenious acid and sulphur. The arsenious acid thus formed is immediately attacked by the sulphuretted hydrogen and thrown down as arsenic trisulphide.

Determination of Ash.—F. A. Flückiger.—The substance in question is heated so slightly in a roomy platinum or porcelain crucible that it is carbonised without flame. It is convenient to cover the capsule with a net of platinum wire. When the emission of vapours has ceased it is let cool, an abundance of water is added to the spongy carbon, and it is perfectly dried on the water-bath. When this is effected it is again heated very gently (to prevent loss), and the temperature is raised very gradually. In general the carbon smoulders away very rapidly; but if not, the treatment with water is repeated and the ignition begun again.

Determination of Albumen in Urine.—Dr. H. Schauman.—Already inserted.

Apparatus for Generating Chlorine.—A. Vosmaer.—The apparatus cannot be intelligibly described without the accompanying figure. The author states that chlorine thus obtained is free from oxygen.

Salicylic Acid for the Preservation of Standard Solutions.—Hugo Bornträger.—The author finds that a standard solution of sodium thiosulphite was preserved unchanged for six weeks by the addition of a little salicylic acid. He ascribes the decomposition of many normal solutions to micrococci in the distilled water.

The Rate of Evaporation as a Measure for Vapour-Pressure.—W. Müller-Erzbach.—The editor merely mentions this method, and refers for the details to *Annalen der Physik und Chemie* (xxxi., 1040).

Changes in the Weight of Bodies on Variation of the Hygrometric Condition of the Surrounding Space.—G. Papasogli (*L'Orosi*).—The author examines if the watery vapour which condenses on dried substances during weighing is indicated by a sensitive balance. He found that if the doors of the balance-case are kept open whilst weighing a dried substance, a perceptible increase of weight ensues. Pulverised substances, dried over sulphuric acid, take up from 1 to 3 m.grms. during the time of weighing (three to six minutes).

The Absorption of Gases by Petroleum.—St. Gniewosz and Al. Walfiscz (*Z. Physik. Chemie*).—The coefficient of absorption of petroleum for oxygen and many other gases is much higher than that of water. The authors conclude that the superstratification of aqueous liquids with petroleum in order to preserve them from oxidation is illusory.

A New Form of Photometer.—W. Grosse.—A mere reference to the *Zeitschrift fur Instrumentenkunde.*

Electrolytic Apparatus.—Various arrangements due to W. H. Herrick (*Journal of Analytical Chemistry*) and N. von Klobulow (*Journal fur Praktische Chemie*).

A Mercury Valve in place of Glass- and Pinch-Cocks.—C. Reinhardt.—This appliance is especially for use with burettes containing stannous chloride. The lower end of the syphon tube is allowed to dip in a small cylindrical vessel of vessel of mercury. Above the level of the mercury is a lateral tube bent slightly downwards, and serving for the outflow of the liquid. The mercury vessel is suspended by means of a bayonet-point to a thickened part of the syphon, and can be lowered when the syphon begins to act.

Self-acting Apparatus for Washing Precipitates.—A. Wahl (*Chemiker Zeitung*).—A flask is closed with a stopper having three perforations, one of which admits a syphon having its opening over the filter, whilst the shorter limb reaches down to near the bottom of the flask. Through the second perforation there enters a tube for the supply of water, regulated by a screw pinch-cock. The third orifice admits a tube open at both ends for the escape of air.

The Determination of Ammonia.—Th. Schlösing.—From the *Comptes Rendus.*

The Direct Precipitation of Nickel in Presence of Iron.—Thomas Moore.—From the Chemical News.

Analysis of Nickel Silver.—Thomas Moore.—From the Chemical News.

Separation of Lead from Bismuth.—H. Hermann.—From the *Journal of Analytical Chemistry.*

Separation of Tin and Antimony.—Ad. Carnot.—From the *Comptes Rendus.*

The Soda-lime Method for the Determination of Nitrogen.—W. O. Atwater and C. D. Woods.—From the *American Chemical Journal.*

The Stalagmometer, an Instrument for Determining the Proportion of Fusel Oil in Spirits, Determination of Alcohol and Acetic Acid.—J. Traube.—This paper requires the accompanying figure.

A Further Method for the Bacteriological Examination of Air.—Dr. Percy Frankland.—From the *Philosophical Transactions.*

Determination of Dry Matter in Syrups, &c.—M. Courtonne.—The author weighs about 2 grms. of the sample into a small flask, heats the flask for a few minutes in the water-bath, and exhausts the flask with the air-pump, still heating. Desiccation is effected in thirty minutes, giving a constant result.

Detection of Methylic Alcohol in Ethylic Alcohol.—J. Habermann.—A modification of the Cazeneuve-Cotton permanganate process. In order to eliminate

from commercial alcohol or brandy certain impurities which, though not identical with methylic alcohol, have a similar reducing action, Habermann shakes up 30 to 40 c.c. of the sample with 20 c.c. of the purest olive oil in a parting-funnel. The shaking must not be violent, but protracted. It is then let stand quietly until the fatty oil has separated from the alcoholic-aqueous liquid. The oil is poured off and the alcoholic-aqueous liquid, with 20 c.c. more oil, are again put in the funnel, and the process of shaking and separation is repeated, as above, and the alcohol freed from the oil is then passed through a double filter, well wetted. The clear filtrate has no smell of an ethereal oil, and, if no sugar is present, it can be at once examined for methylic alcohol by the process of Cazeneuve and Cotton. If sugar is present it is got rid of by means of distillation, the distillate being taken for examination.

Resistance of Materials to Frost.—Ad. Blümcke.—The author places cubes of the material in question, covered with distilled water, under the bell of an air-pump. On evacuating, the pores of the material are filled with water. It is then exposed to the action of a freezing mixture in a peculiar apparatus. The smaller the weight of the particles which a cube loses after a given number of freezings, the greater is its resistance to frost.

Recognition of Sulphonal.—M. Scholvien.—Pure sulphonal melts at 125·5, dissolves in 15 parts boiling water and 500 parts water at 15°. It dissolves in 2 parts of boiling alcohol, in 133 parts alcohol, 133 parts of ether, and 110 fifty per cent alcohol, all at 15°. Besides determining the melting-point, it should be examined for sulphuric acid, potassium, and manganese.

Detection of Phenacetine in Acetanilide.—If the hydrochloric solution is diluted with 10 vols. water and a few drops of a 3 per cent solution of chromic acid are added, the liquid becomes of a ruby-red if phenacetine is present. If the acetanilide is pure the solution remains yellowish.

Direct Detection of Chloral or Chloroform in Liquids.—C. Schwarz.—If a solution of resorcine containing traces of chloral hydrate or chloroform is heated to a boil with excess of soda-lye there is formed a red colour, which disappears on acidulation and returns on the addition of an alkali. If 0·1 grm. chloral hydrate or chloroform is heated with an excess of resorcine (0·3 grm.) and very little soda-lye to a strong boil, there is produced a yellowish red liquid which, even when extremely diluted, shows a splendid yellowish green fluorescence.

The Atomic Weight of Gold.—G. Krüss, T. E. Thorpe, P. A. Laurie, and J. W. Mallet.—Krüss obtains, as the mean value, 196·64; Thorpe and Laurie give Au = 196·852 (O = 15·96), and Mallet, whose researches are not completed, considers all these figures too low.

MISCELLANEOUS.

Department of Science and Art.—Mr. W. Crookes has presented to the Department of Science and Art a collection of 68 radiometers and similar instruments for permanent exhibition in the Science Galleries of the South Kensington Museum. They illustrate the steps by which Mr. Crookes was led to the construction of the radiometer, and to the production of motion and of phosphorescence by streams of electrified molecules in high vacua. Many of the instruments are of the greatest historical interest. Among them is included the first radiometer, with many others which are described in Mr. Crookes's papers in the *Philosophical Transactions of the Royal Society*. Nearly all are in working order, and will be of great use in illustrating lectures to students in the Normal School of Science at South Kensington. The collection will be on view in the galleries of the museum in Queen's Gate as soon as the necessary stands and fittings are completed.

Royal Institution.—The next Course of Christmas Lectures adapted to a juvenile auditory will be given by Professor Dewar, F.R.S., the subject being "Clouds and Cloudland." They will begin on December 27. During the recess the staircases leading from the gallery of the theatre have been considerably altered in order to facilitate more speedy egress.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Glazes for Earthenware.—Can any correspondent tell me title, author, and cost of a good book on Glazes and Glazing for Earthenware, such as terra-cotta, white ware, &c.—W. J. COOPER.

Earrings.—In "The Correspondence of the Right Honourable Sir John Sinclair, Bart.," vol. ii., p. 309 (London, 1831), writing on Vienna and the state of society there in 1786, the following passage occurs:—"The dust likewise occasions complaints in the eyes; numbers of men on that account wear earrings, which they insist are good for the eyes; the hole in the ear and the weight of the earring drawing any humour in the eyes to those parts." Will any contributor, foreign or otherwise, kindly inform me whether this theory mentioned by Sinclair regarding the beneficial effect of earrings in reference to men's sight in Vienna has ever been criticised in any German chemical or medical publication of that metropolis, giving also the name of periodical and date?—MARIA TIBUS.

MEETINGS FOR THE WEEK.

MONDAY, 26th.—Medical, 8.30.
— Society of Arts, 8. (Cantor Lectures). "Light and Colour," by Capt. W. de W. Abney, F.R.S.
TUESDAY, 27th.—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
WEDNESDAY, 28th.—Society of Arts, 8. "The Phonograph," by Col. Gouraud.
FRIDAY, 30th.—Royal, 4. (Anniversary).

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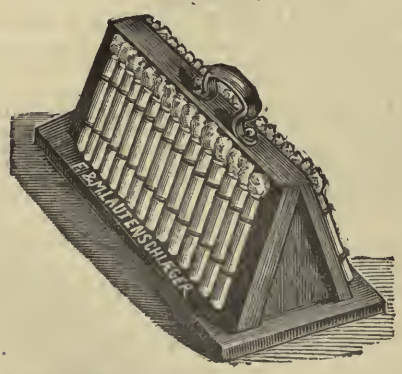

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1514.

"SEALED PAPERS."

If we read the accounts of the meetings of foreign scientific societies we find it not unfrequently stated that M. A.B. or Herr X.Y. demanded that a "sealed paper," which he had deposited with the secretary some time ago, should be opened and read. This is accordingly done, and M. A.B. or Herr X.Y. aforesaid, is sometimes, in consequence, proclaimed to have been the "first and true discoverer" of some novel fact or of some important generalisation. It not unfrequently happens that such fact or generalisation has been come upon or arrived at by some other *savant*, who, of course, has been in complete ignorance of the contents of the mysterious document, but now finds that he has been anticipated.

How this custom of depositing "sealed papers" has sprung up it is not hard to conjecture. An investigator in any science may have come upon the track of some phenomenon or some conclusion, but from lack of time, of materials, or of facilities of other kinds, he may be unable to follow up the clue which has thus come into his hands. To secure his rightful claim he therefore sends in to some society a "sealed paper" containing a sketch of his results. Should anyone else take up and work out the subject, the depositor is always thus enabled to claim priority.

Now, so far little harm is done. But, unfortunately, the system of "sealed papers" lends itself to a serious abuse, which we will endeavour to explain. In research, whether in chemistry or some other science, we often reach a point where two—or more—alternatives present themselves. Let it be the valency of one of the less known elements, the product of a certain reaction, or the constitution of a newly-discovered compound. We may be fairly certain that one of the alternatives *must* be true, but to find out which is *the* one may require a course of prolonged and delicate experimentation. Such experimentation the conscientious chemist cheerfully undertakes, or else frankly leaves the task to others. But, if he is more mindful of his own *kudos* than of the progress of science, and craves to reap where another has sown, he finds the sealed paper supplies him with the means. He writes down each alternative in a separate paper, seals them up, and numbers them, carefully noting down the contents of each, and then hands them in for safe keeping to the Council of some Society. Months, or perhaps years, may elapse, and the papers still slumber in their pigeon-holes, their contents known to no man save the depositor. One day a memoir is read before some other society, or appears in some other journal, fully and finally solving the question at issue, and its author obtains due credit. But now steps forward the depositor, and requests that "sealed paper" No. 2, deposited on such a date, be opened and read. In this paper our hero is found to have anticipated the result which has just been given to the world, and goes off in triumph. True, his announcement may be couched in language more oracular than explicit. True, also, that his co-discoverer has worked in perfect independence. Still, the depositor obtains credit which is not justly his. As for the other sealed papers, which had been prepared in case some other alternative had been demonstrated, they may remain for ages in the desk of M. le Secretaire. Indeed, we believe that in some cases the depositor may have them destroyed unopened.

Now, there is a method in common use, both in Britain and in Germany, which answers every good end of the sealed paper, without lending itself to the above-mentioned abuse. The *savant* who thus comes upon some novel phenomenon, which he has not time to work out in detail, simply reads a preliminary notice, and adds that he either reserves the further investigation of the subject to himself, or, that his time, &c., not permitting him, he hands it over to his colleagues. By this plan all rights are secured and no wrongs are facilitated.

As we hear of attempts made to introduce the "sealed paper" system into this country, we shall be happy to hear the views of our readers on the question.

THE SENSIBILITY OF EARTH-NUT OIL TO HEAT WHEN ELECTRIFIED.

By THOMAS T. P. BRUCE WARREN.

When working on the electrical resistances of the fixed oils, a short time ago, I found that earth-nut oil (*Arachis hypogea*), when electrified, became so extremely sensitive to heat, that every precaution was necessary to avoid changes of temperature when testing.

The apparatus used was designed for measuring the resistance corresponding to unit volume.

Two fixed parallel silver plates, insulated from each other, were placed in a test-tube, and the oil afterwards poured in. The galvanometer deflection was noted in the usual way, the tube being slightly held between the fingers. The deflection *increased*, whereas the same oil, tested in the cylindrical form of apparatus, gave a deflection which *decreased* on prolonged contact with the battery. The difference could only be accounted for by the warmth of the fingers reducing the resistance.

The tube was then wrapped with several layers of cartridge paper, and held in a cork fitting into an ordinary hydrometer glass, the annular space between the two glasses was filled in with layers of paper, coiled round the tube. The whole arrangement was allowed to stand in the neighbourhood of the galvanometer for twenty to twenty-four hours before testing. The behaviour of the oil now was similar to what it had been when tested in the cylindrical form of apparatus.

The following experiments were made with a view of ascertaining how far the warmth of the fingers had contributed to the previous result. On slightly touching the outer glass the deflection rose, and continued rising as long as the glass was touched; on clasping the outer glass the deflection increased rapidly, and, curiously, the deflected position was permanent on removal of the hands. Experiments were made to ascertain if these effects were, in any way, due to induction, with negative results. A lighted wax vesta was held about twelve inches from the cylinder, with the same result which was found by clasping with the hands, though in a less degree.

To realise the significance of these results, it is important to bear in mind that the annular space between the two glasses was nearly half an inch, and this was well filled in with a medium impervious to the rapid transmission of heat. In this case the outer glass, touched slightly with the finger, showed the same instantaneous result.

Even the very best solid conductors, such as copper or silver, do not show this remarkable behaviour to heat. It is no exaggeration to say that a mere fraction of a degree of temperature is rendered instantly visible.

An important and interesting question opens up, whether electrification increases the susceptibility of bodies to heat? At any rate, no other oil behaves in so pronounced a manner, but a mixture containing earth-nut oil shows this susceptibility in a degree proportional to the quantity present.

A few practical applications may arise from this, notably the construction of an electrical thermometer, when we consider the time required for heat to permeate a thin layer of indiarubber, gutta-percha, varnishes, &c.

THE FORMATION OF OXYGEN FROM MANGANESE PEROXIDE AND POTASSIUM CHLORATE.

By V. H. VELEY.

As regards the communication of Mr. H. N. Warren (Chemical News, vol. lviii., p. 247), I would wish to point out that in a recent paper "On the Conditions of the Evolution of Gases from Liquids" (*Phil. Trans.*, 1888 (1), 271), I have shown that substances, in their nature chemically inert, promote the evolution of oxygen from potassium chlorate. Thus, in a comparative experiment, into the details of which it is not necessary to enter, it was ascertained that the presence of as small a quantity as one per cent of precipitated barium sulphate in the potassium chlorate caused an increase in the rate of evolution of oxygen from the salt. Further, it was noted that, whereas oxygen was given off from a mixture of potassium chlorate and manganese peroxide at a temperature below the point of fusion of the salt, yet, under the same conditions, little or no gas was given off from a similar mixture of potassium chlorate and barium sulphate. Thus the two phenomena differ in degree; doubtless they result from different causes. The former is in accordance with other observations by Mr. Vernon Harcourt and myself on the effect of finely-divided particles in promoting the evolution of gases from liquids. As regards the latter, the effect is the result of mixed causes, viz., the finely-divided state of the manganese peroxide, and the chemical interaction between it and potassium chlorate.

It is generally stated in the text-books that the efficiency of manganese peroxide is due to the alternate formation and decomposition of potassium manganate. But this view has not, so far as I am aware, been supported by any experimental evidence. It would appear more probable that the comparatively unstable manganese dioxide, viz., the substance represented by the chemical symbol MnO_2, is alternately formed and decomposed. The experiments of Mr. Pickering and myself (*Journal of the Chemical Society*, 1879, 659; and 1880, 585) have established that manganese peroxides, containing a proportion of oxygen less than that required for the atomic ratio $Mn : O_2$, absorb oxygen, when heated to 160° to 200°, and yield it up again at a higher temperature. This alternate absorption and evolution of oxygen under the conditions of temperature required may account for the peculiar effect of manganese peroxide. The efficiency of litharge may equally be due to the alternate formation and decomposition of the dioxide.

It would be interesting to compare the relative effects of the various metallic oxides stated by the text-books to be efficient, as also to confirm the statement that these oxides are unaltered at the end of the reaction. We are even now in the dark as to the explanation of this chemical changê, which is generally the first presented to a beginner in the study of chemistry.

University College, Oxford
Nov. 20, 1888.

NOTE ON ERYTHROXYLON COCA GROWN IN INDIA.

By C. J. H. WARDEN, M.D., F.R.C.S.

(Continued from p. 251.)

In addition to the samples, the composition of which I have given in Table No. I., I also examined two lots of leaves grown at Amgoorie, Assam; one sample, which I shall designate A, was treated like the tea leaf and allowed to ferment one hour after rolling, before it was dried; the other sample, B, was dried at once after rolling.

	Moisture.	Ash.	Alkaloid.
A sample	4·36	9·83	0·419
B „	6·47	—	0·445

The character of the ethereal extract yielded by these samples differed in no wise from the extracts yielded by samples of leaves which had been dried by simple exposure to heat. In both the samples the ethereal extract possessed in a marked degree the physiological action of cocaine when applied to the tongue.

In order to determine whether or not the process of assay I had adopted was a cause of the non-crystalline character of the alkaloid, I tried a variety of experiments. In Squibb's process heat is employed to evaporate the alcoholic extract of the leaves, and the fluid is always strongly acid in reaction: to render the alcoholic solution as free from acid as possible, I added oxide of magnesia before evaporation. The extracts, however, obtained did not differ from those yielded by the ordinary process. I may mention here that in all my estimations a very low temperature was used for driving off the alcohol. The water in the water-bath being kept at from 70° to 80° C., and the capsule containing the liquid not being in contact with the steam, but merely placed on the closed metal top of the bath. But low as this temperature was, in some experiments I avoided the use of heat altogether in the extraction of the alkaloid by percolating the leaves with water acidulated with sulphuric acid, and treating the percolate with ether and carbonate of soda in the usual way. The ethereal extract obtained by using this process also failed to crystallise spontaneously. In certain experiments I used acetic acid for acidifying the alcohol employed for percolating the leaves, but the ethereal extract also failed to crystallise. These experiments appeared to me to be sufficiently exhaustive to indicate that it was not the method of extraction employed which prevented the alkaloid from crystallising. I have already indicated that in curing the leaves heat was used, and it appeared to me that possibly the temperature employed might have been sufficiently high to cause decomposition of a portion of the alkaloid present in the leaves. In order to test the correctness of this supposition, I obtained from Mr. Blechynden a sample of fresh leaves grown in the Society's Gardens at Alipore. These leaves were plucked in the morning, and when received by me a few hours later were still perfectly green. I divided the sample into three portions—one portion, A, was reduced to pulp and extracted with alcohol, &c., in the usual way. The second portion, B, was first partially dried by being exposed to the air in the laboratory for four days, the temperature varying between 85° and 90° F. The leaves were then placed in a water-oven and heated to 100° C. for six hours. The remaining portion, C, was dried under a hot plate at a temperature of 77° C., with free exposure to air. The results obtained on analysis are shown in Table No. V.

Table No. V.

Sample.	Moisture.	Ash.	Total alkaloid.	Total alkaloid calculated on anhydrous leaves.
A	66·09	3·09	0·330	0·973
B	1·27	—	1·004	1·01
C	3·14	—	1·035	1·06

In sample B the ethereal extract was of a much darker colour than that yielded by the other two samples; physiologically there was no difference as far as I could ascertain between the different extracts. The ethereal extract from the sample in which the undried leaf pulp had been used, had an odour not unlike that of Indian hemp extract, which was very marked, and which was to a considerable extent absent from the other extracts. These three extracts, however, all failed to afford any indication of crystallisation. I made several experiments, using alcohol, chloroform, &c., as solvents for the ethereal extract, in the hope of obtaining a crystalline alkaloid, but with negative results.

The ethereal extracts obtained in the course of my experiments were easily soluble in dilute hydrochloric acid, but the hydrochloric acid solution also failed to afford on spontaneous evaporation a crystalline salt. Certain samples of the hydrochlorate of cocaine solution I dried over concentrated sulphuric acid, a transparent faintly yellow varnish-like mass was the result, which was decidedly hygroscopic on exposure to air. Other samples I evaporated on a water-bath at a low temperature, also with negative results, as far as a crystalline product was concerned. I found, however, that by using the full heat of a water-bath and constantly stirring the solution, that a sticky mass was obtained which on cooling was brittle and could be rubbed to a powder; but this powder was hygroscopic, and a short exposure to air was sufficient to convert the powder into the original sticky varnish-like body.

In a paper by Dr. Howard in the *Pharmaceutical Journal*, to which I have already referred, a method is described for the separation of cocaine from the amorphous matter of an alkaloidal nature with which it is stated often to be associated by means of platinic chloride. According to Howard platinic chloride precipitates both cocaine and the amorphous alkaloid, but while the double chloride of cocaine and platinum forms a salt soluble in water at 80° C., the amorphous platinum compound is insoluble under similar treatment. On analysing these platinum compounds Howard obtained 19·16 per cent of platinum from the soluble salt, and 18·54 per cent of platinum from the insoluble compound. The percentage of platinum obtained from the soluble platinum salt corresponds fairly with that which should be yielded by a salt having the composition $(C_{17}H_{21}NO_4HCl)Pt_2Cl_4$, and Howard states that the base giving the soluble platinum salt is cocaine. The base, on the other hand, obtained from the insoluble platinum salt is described as being extremely bitter, gives no crystallisable hydrochlorate, and produces no anæsthetic effects. It is not the hygrine described by Lossen, because that base affords a hydrochlorate which crystallises freely, has no bitter taste, and gives a platinum salt which is decomposed by heating the liquid. Howard on these data concludes that the base giving the insoluble platinum salt probably contains three atoms more of carbon than cocaine; and that amorphous cocaine has no existence, but is a solution of cocaine in the base above described. In order to test the correctness of the views advanced by Howard, I made some experiments with the platinum salts of the alkaloids extracted from the coca leaves. And first as regards the solubility of the two platinum compounds: I found that even using water at 15° C. for washing the precipitate produced by platinum chloride in a hydrochloric acid solution of the bases, it was practically impossible to determine at what point to stop washing the precipitate, for on using a large volume of water, very little insoluble residue was left on the filter. I prepared a solution of the ethereal extract of the leaves in dilute hydrochloric, taking care to avoid an excess of acid being present in the liquid; this solution was precipitated with an excess of platinum chloride, and largely diluted with water. The solution was then filtered, and the residue on the filter well washed with water. The filter with its contents was dried over sulphuric acid in vacuo; the platinum salt yielded on analysis the following percentage of metallic platinum:—0·0992 grm. gave 0·0186 grm. platinum, equal to 18·75 of platinum calculated on the salt. A second lot of ethereal extract, treated in the same manner, gave a platinum salt which afforded the following percentage of platinum on ignition:—

I. 0·1776 grm. gave 0·0336 grm. platinum.
II. 0·2420 „ „ 0·0460 „ „

These results are equal to 18·91 and 19 per cent of platinum respectively calculated on the salt. The three analyses of the insoluble platinum salt agree fairly, and give a mean of 18·88 per cent of platinum in the compound. In order to determine the composition of the soluble platinum salt I recovered the base from the filtrate and washings of the insoluble platinum salt, by adding ammonia and agitating with ether. The ethereal extract was neutralised with hydrochloric acid, and precipitated with platinum chloride, from a concentrated solution. The precipitate was washed with ice-cold water, and finally dried over sulphuric acid in vacuo. On igniting the platinum salt the following results were obtained:—

I. 0·1776 grm. gave 0·0334 grm. platinum.
II. 0·0962 „ „ 0·0180 „ „

equal to 18·80 and 18·71 per cent of platinum calculated on the salt, and a mean of 18·75 per cent for the two experiments. Howard found that the alkaloid present in the soluble platinum compound had the properties of cocaine, while that present in the insoluble platinum salt was another base which produced no numbing effect on the tongue. My experiments with coca leaves grown in India are not in accord with those of Howard: I found the base extracted both from the soluble and insoluble platinum compound produced a marked anæsthetic effect on the tongue. In one of my experiments the alkaloid obtained by decomposing the soluble platinum salt yielded on spontaneous evaporation of its ethereal solution a few star-shaped crystals, and this was the only instance in which I obtained a crystalline base on spontaneous evaporation. O. Hesse, in a paper on "The Alkaloids of Coca leaves,"* states that from the amorphous portion of the coca bases which can be easily separated from cocaine, he obtained a platinum salt that yielded, in two experiments, 18·26 and 18·44 per cent of platinum, the amount of water being respectively 5·0 and 5·5 per cent. Calculated on the anhydrous salt this would be equivalent to 19·22 and 19·51 per cent of platinum, and accordingly the amorphous base would appear to have the same composition as cocaine. Hesse also states that this amorphous material is not homogeneous, since he was able to separate from it by fractional precipitation a well-defined base, which he calls cocamine, but which he was only able to obtain from a small leaved variety of coca. This base has also the same empirical formula as cocaine. The hydrochlorate of this base is amorphous, but it yields a crystalline platinum salt containing four equivalents of water of crystallisation which is only lost at 120° C. Howard does not state the temperature at which his insoluble platinum salt was dried; if it was dried over sulphuric acid, in the same manner as the soluble platinum compound, it was probably not anhydrous, and hence yielded a lower platinum percentage than the soluble platinum salt. The mean platinum content of the three insoluble platinum compounds I examined is equal to 18·88 per cent compared with 18·75 of platinum in the soluble platinum salt. All my platinum salts were dried over sulphuric acid in vacuo, and were probably not anhydrous. Possibly my platinum salts were mixtures of the hydrochlorates of cocaine, with Hesse's base cocamine. And this assumption would also be borne out by the fact that I have obtained, by operating with a sample of alkaloid extracted from leaves grown in a different district to those employed for the isolation of cocaine used in the experiments I have already quoted, a soluble platinum salt which yielded, after drying in vacuo over sulphuric acid, 19·3 per cent of platinum on ignition. The amount of alkaloid at my disposal was very small, and I was unable to make duplicate analyses, or to estimate the amount of platinum in the so-called insoluble platinum compound. I would suggest as an explanation of the fact of my platinum percentages for the soluble platinum salts used in the first experiments being lower in platinum than the percentage which should theoretically be yielded by the hydrochlorate of cocaine and platinum being due to the varying amounts of Hesse's base cocamine contained in Indian grown coca leaves.

* *Pharm Zeitung*, July 18, 1877

John Williams, in the *Pharmaceutical Journal*, September 24, 1887, describes a method of testing the hydrochlorate of cocaine for impurities. The method he recommends depends upon the almost absolute insolubility of the hydrochlorate of cocaine in ether, and the fact that most, if not all the ordinary salts or impurities appear to be soluble in ether when converted into hydrochlorate. In order to apply the test, the hydrochlorate is dissolved in the smallest quantity of absolute alcohol, and to this solution about six times the volume of pure anhydrous ether is added, and the mixture well shaken. Under these conditions the hydrochlorate of cocaine separates as a crystalline precipitate, while the impurities remain dissolved in the ether. Operating in the manner described by Williams, I found that the hydrochlorate of the crude alkaloids extracted by Squibb's method contained only 2·89 per cent of impurity. The action of ether, however, on the absolute alcohol solution of the hydrochlorate was different to that described by the author. On the addition of ether to the alcoholic solution no crystalline precipitate was produced, the base adhered to the sides of the flask at first in what had the appearance of minute crystals, and these crystals rapidly coalesced and formed minute globules, and this result also ensued when a larger volume of ether was used than that ordered by Williams. Under the circumstances it was impossible to collect the hydrochlorate of cocaine on a filter.

In estimating the alkaloids contained in coca leaves, and using relatively the same amount of solvent and leaves in all the experiments, I was struck with the variations in the amount of coca-tannic acid present in the various samples. On adding ether to the acidulated alcoholic extract to remove colouring matter, and in many instances on allowing the mixture to stand, the coca-tannic acid separated out as a sulphur-yellow deposit on the sides of the bottle. It was also of interest to note that the largest deposits of coca-tannin occurred in those samples which yielded the highest percentage of alkaloid. It appears to me, therefore, as not improbable that in the leaves the cocaine is in combination with the acid to which this term coca-tannic has been applied.

There is one last point to which I would refer in connection with the chemistry of the extraction of cocaine from the leaves. The volatile base hygrin has often been mentioned in this communication. I endeavoured to isolate it from the fresh and undried leaves by distillation with water. The distillate had the peculiar odour of the leaves, was distinctly acid in reaction, and failed with the usual alkaloid reagents to afford the slightest indication of the presence of a basic principle.

(In the "Report on the Progress and Condition of the Government Botanical Gardens and Parks, Nilgiris, for 1884-5," it is stated that two big bushes of *E. coca* exist at Barliyar, where they grow freely, but fruit sparingly. Mr. Hopper, the Government Quinologist, has analysed three samples of the leaves taken from these bushes. In his first attempt to isolate the alkaloid in a crystalline state he was unsuccessful; in his second attempt he succeeded in obtaining the alkaloid crystalline, but with an admixture of some acrid principle, which rendered it useless as an anæsthetic; his third attempt ended in complete success, and the alkaloid manufactured by him has been used, and approved of, by Dr. Brockman in his surgical ophthalmic operations. Mr. Hopper obtained 0·5 per cent of alkaloid from the leaves).

(To be continued).

Why Rails in Use Rust less quickly than Rails at Rest.—W. Spring.—The preservation of rails in use is not the result of vibratory motion, or of an electric action due to the passage of the trains, but to the formation of magnetic oxide produced by the compression of the rust on the metal. The rails are thus protected against the action of moist air in the same manner as is iron oxidised by fire.—*Bull. de la Soc. Chim. de Paris.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, November 15th, 1888.

Mr. William Crookes, F.R.S., President, in the Chair.

Certificates were read for the first time in favour o Messrs. Carl Duisberg, Ph.D., Farbenfabriken, vormals Bayer and Co., Elberfeld; Lionel Remond Lenox, Ph.D., Lehigh University, South Bethlehem, Pennsylvania; George Lloyd, 25, Kensington Gardens, Balsall Heath, Birmingham; James Muir, Staunton Harold, Branksome Park, Bournemouth; Robert Hodgson Parker, 26, Harford Street, Norwich; John Percival, B.A., 58, Harwood Road, Walham Green, S.W.; Percy Andrew Ellis Richards, 44, Sinclair Road, Kensington; Emanuel Roberts, Moratna, Ceylon.

The following were duly elected Fellows of the Society:—Messrs. Walter Bromley Cooley, John Burke Fairley, Walter M. Gardner, Archibald Carlyle Mounsey Ingram, Frank Pullinger, A. Alexander Ramsay, Clement J. Rhodes, C. Heinrich Trinks.

The following papers were read:—

79. "*The Principles of Thermochemistry.*" By S. U. Pickering.

The author rejects the thermochemical principles enunciated by Thomsen, Naumann, and Berthelot, not only on special grounds, but on the more general ground that they depend on an impossible distinction between chemical and physical actions. A satisfactory explanation of all known thermochemical facts is derived from the recognition of the laws of dissociation and the hydrate theory of dissolution. Every act of combination must be accompanied by the evolution of heat, and in interactions where heat is absorbed this absorption must be due to the fact that one or more of the agents being partially dissociated at the temperature of the interaction, the removal of one of the products of the dissociation necessitates a further decomposition of the agent. The heat evolved must also be a direct measure of the affinities saturated, and, of two possible interactions, that which evolves more heat must occur to the exclusion of the other.

The cases of endothermic changes which present difficulties are those in which liquids and solids are concerned. The heat absorbed when many solids are dissolved in liquids cannot be explained by the fusion, but only by the volatilisation of the solid. A mass of water contains some fundamental molecules possessing an energy of 10,000 cal. greater than the average molecular aggregates constituting the mass. These can therefore combine with the salt, and effect its volatilisation with an evolution of heat, even if the heat of volatilisation be nearly 10,000 cal.; other water aggregates then dissociate to supply the place of the free molecules thus removed from the sphere of action.

From theoretical considerations the author arrives at the conclusion that Berthollet's theory as to the division of a base between two acids is correct—that two acids present in equivalent proportions should divide the base equally between them; that, since sulphuric acid acts as a monacid in this respect, H_2SO_4 should be compared with HCl and not with 2HCl; and that if one of the two acids form a dissociable salt, it would take none or very nearly none of the base. The facts observed, the author argues, are in accordance with these conclusions, and are entirely opposed to the existence of the so-called "avidity" or "affinity" constants advocated by Ostwald and others.

The reason why sulphuric acid acts as a monacid in this respect, or in other words why H_2SO_4 and K_2SO_4 interact to form $2HKSO_4$ in spite of the absorption of heat accompanying the action, is that lower hydrates (especially

of the acid) are present, and that with these lower hydrates the interaction is exothermic, and therefore necessarily occurs, the absorption of heat noticed being due to the dissociation of the higher hydrates to supply the place of the lower ones thus removed from the sphere of action.

Discussion.

Professor Ramsay said that it was merely a matter of nomenclature to distinguish physical attraction, in which each molecule present attracted every other molecule according to some law comparable with the law of gravitation from chemical attraction, in which selective attraction is exercised; but that he preferred to draw the distinction, where possible, in order to save confusion, though it might be difficult in some cases to do so. He did not believe in the universal presence of complex molecules in liquids and solids; nor did he exclude the existence of such; the researches of Professor Young and himself, he thought, conclusively established the absence of a complex molecular structure in such liquids as ethyl alcohol and ether; while on the other hand Henry's arguments testified to the complexity of the molecules of certain oxides, such as silica. And with regard to water, which specially formed the subject of Mr. Pickering's remarks, while the vapour-density pointed to molecular simplicity, other arguments drawn from its behaviour when examined by Raoult's method were in favour of moderate complexity.

Dr. Armstrong said that he agreed with Mr. Pickering, and thought that it would be necessary in the future to attach a far wider significance to the term chemical action, and to greatly restrict the use of the term physical action —that, in fact, very many so-called physical changes would be found to involve a change in molecular composition or configuration. It was conceivable that in certain cases such as Professor Ramsay had mentioned, molecule acted upon molecule chemically, but in such manner that the molecular aggregate was of the dimensions of the mass. By taking into account the action of water, Mr. Pickering had advanced what appeared to be a rational explanation of many facts which hitherto had appeared paradoxical.

Mr. Pickering, in reply to Professor Ramsay, said that the fact that gaseous water was of normal density appeared to him compatible with the existence of complex water molecules: probably a sudden change attended liquefaction or gasification. This argument might be of general application.

80. "*Note on the Mixture of Propyl Alcohol and Water.*" By Professor Ramsay, F.R.S., and Professor Young.

Chancel has called attention to the fact that a mixture of propyl alcohol and water in the proportions C_3H_8O : H_2O distils over to the last drop at 87·5° (press. = 738 m.m.). Konowalow, however, determined the vapour-pressure of mixtures of the alcohol and water, and arrived at results adverse to the conclusion that a definite hydrate exists, and the authors are of similar opinion. They found that the vapour-pressures of the mixture determined by the statical method were uniformly higher than those determined by the dynamical, but the difference is very small and far less than is observed with most dissociating substances, the behaviour being more nearly that of an imperfectly purified stable substance. The results of vapour-density determinations seemed to point to a rise of density with fall of temperature and increase of pressure, but it was afterwards found that the greater part of the rise was due to condensation, probably of water, on the side of the tube. A percentage contraction of 1·85 was observed on mixing the alcohol with water—71·46 per cent alcohol to 28·54 per cent water. The composition of the mixture of constant boiling-point was found to vary with the pressure under which it was distilled.

Discussion.

Mr. Howard expressed the opinion that propyl alcohol and water formed a definite compound until vaporised; the behaviour of the various lower alcohols with water, and the fact that the solubility of amyl alcohol in water diminished as the temperature rose, all tended to prove that the alcohols formed hydrates.

Professor Young, in support of the opinion that the mixture was not a hydrate, recapitulated the arguments which he and Professor Ramsay had advanced in previous papers in discussing the properties of various liquids and liquid mixtures.

81. "*Note on the Action of Nitric Acid on Ammonium Chloride.*" By F. G. Mathews, Ph.D.

The principal gaseous product of the action of nitric acid on ammonium chloride in solution is nitrous oxide, and not nitrogen, as has been previously stated; the gas is mixed with small quantities of chlorine and oxychloride of nitrogen, from which it may be freed by washing with sodium hydroxide. The nitrogen of the nitric acid, as well as of the ammonium chloride, is concerned in the formation of the nitrous oxide. The interaction is of general application, and takes place in all cases in which a solution of an ammonium salt is heated in the presence of nitric acid and hydrogen chloride.

82. "*Ethylic Cinnamyldiethacetate.*" By F. G. Mathews, Ph.D.

A simpler method of preparing ethylic cinnamyldiethacetate than has been previously known is to allow a mixture in molecular proportions of benzaldehyde and ethylic diethacetoacetate saturated with hydrogen chloride to stand for about a month: the product separates slowly in crystals which are practically pure ethylic cinnamyldiethacetate. On hydrolysis with barium hydroxide, cinnamic and diethacetic acids are produced, small quantities of a ketone only being formed. An attempt to prepare the corresponding monethyl-derivative in a similar manner failed. On trying to prepare similar derivatives of ethylic, mono-, and di-methacetoacetate, no products could be isolated, the action appearing to be more complex than in the case of the corresponding ethyl compounds.

83. "*The Isomeric Sulphonic Acids of Betanaphthylamine.*" By Arthur G. Green.

It is known that on sulphonating betanaphthylamine by means of ordinary sulphuric acid, a mixture of α- and γ-acids is produced at low temperatures, and at higher temperatures (160—170°) a mixture of β and δ: according to the formulæ usually assumed for these acids, the first pair have their sulpho-groups in α-positions, the second pair in β-positions; and their formation is exactly analogous to that of the α- and β-sulphonic acids of naphthalene. According to Dahl, the product at 100° consists of α-, β-, and γ-acids, but the author finds that, as was to be expected, the δ-acid is also present. The four acids can be readily isolated by a slight modification of Dahl's process. The ammonium salts of the four acids were found to differ in a very characteristic manner: that of the β-acid is less soluble than the three isomeric salts, and by means of this salt the β-acid was obtained in a pure state, and was found to crystallise in prismatic needles, not in nacreous plates, the formation of which is shown to be dependent on the presence of δ-acid. Although betanaphthylamine gives four isomeric acids on sulphonation, only two sulpho-acids are supposed to be formed by sulphonating betanaphthol; but bearing in mind the analogous behaviour of hydroxy- and amido-compounds, it would appear much more probable that four acids are formed in the latter case also, and hence a search was made for the δ-sulphonic acid in the product of sulphonation of betanaphthol at 100°. As the separation of isomeric betanaphtholsulphonic acid presents great difficulties, the method adopted consisted in converting the sulphonation product into the corresponding betanaphthylaminesulphonic acids and separating these. By this means it was proved that the product formed at 100° is a mixture of the β- and δ-isomers. Hence at higher temperatures, at any rate, betanaphthol behaves on sulphonation like betanaphthylamine; whether

this is the case at low temperatures also remains to be seen.

Discussion.

Mr. Wynne asked whether Mr. Green had any evidence in favour of the formulæ he had adopted for the α (Badische) and γ (Dahl) betanaphthylaminesulphonic acids. The γ-acid was more usually represented by the formula $NH_2 : SO_3H = 2 : 1'$. With regard to the α or Badische acid, it was to be noted that Cleve had assigned the constitution adopted by Mr. Green to the dichloronaphthalene melting at 34°; that Forsling had assigned the constitution 1 : 3 or 1 : 2 to the dichloronaphthalene melting at 61·5°, obtainable from the Badische acids; and that Erdmann and Kirchhoff had obtained a dichloronaphthalene melting at 61·5°, which was unquestionably heteronucleal. At present, therefore, Mr. Green's formula for the betanaphthylamine-α-sulphonic acid could not be accepted.

Looking at the variation in the proportions of the four betanaphthylaminesulphonic acids formed on sulphonating at different temperatures, Mr. Wynne suggested that the conversion of the α- and γ-acids into the β- and δ-acids at 160° might be explained by supposing that in the presence of the sulphuric acid the α-acid was converted exclusively into the β-acid, and that the γ-acid underwent a similar change into the δ-acid, which itself at higher temperatures (or by a prolonged action of the sulphuric acid at 160°) would undergo conversion into the β-acid. Such a change, though perhaps different in its course, would be analogous in result to that described by Professor Armstrong and himself in the case of the monosulphonic acids of the β-halogen-derivatives of naphthalene, having a constitution similar to that of the Badische acid.

Dr. Armstrong referred to Emmert's observation that the betanaphthol-α-sulphonic acid corresponding to betanaphthylamine-α-sulphonic acid is convertible into a dihydroxynaphthalene different from hydrobetanaphthaquinone, as incompatible with the conclusion that the α-acid was the 1 : 2 compound; moreover, an acid in which the SO_3H and OH groups were in the relative positions 1 : 2 would not, he thought, be capable of forming azo-colours. He then pointed out that the conclusions at which Mr. Wynne and he had arrived concerning the constitution of the dichloronaphthalene obtainable from the Badische acid, were irreconcilable with Mr. Green's formula (cf. the following Abstract).

Mr. Green, in reply, defended the view that the α-acid was the ortho-compound mainly on the ground that it and the corresponding hydroxy-acid differed so greatly in properties from their isomers.

84. "*The Constitution of the Dichloronaphthalenes, especially the $\alpha\beta$-Compounds.*" By Henry E. Armstrong and W. P. Wynne.

The three possible $\alpha\alpha$- and the two possible heteronucleal $\beta\beta$-dichloronaphthalenes are all known, and not only are they known, but there can be little doubt that the formulæ now ascribed to the several modifications (comp. *Abstracts of Proceedings*, 1888, p. 95) are correct expressions of their constitution.

The object of the present note is to point out that the four possible $\alpha\beta$ dichloronaphthalenes are also known, and to draw attention to the explanation of the somewhat discrepant statements on record relating to the so-called θ-modification, melting at about 61°. This was first prepared by Cleve, who obtained it from one of the three α-nitro-acids formed on nitrating naphthalene-β-sulphonic acid; he subsequently obtained a dichloronaphthalene having the same melting-point from a second of these three acids, but left it an open question whether two isomers of the same melting-point existed, or whether an isomeric change took place on treating the nitrosulphochloride with phosphorus pentachloride. Dichloronaphthalene melting at about 61° has since been prepared (1) by Arnell from β-chloronaphthalenesulphonic acid; (2) by Cleve from dichloralphanaphthylamine; (3) by Claus from betanaphthol-α-sulphonic acid (Bayer's modification); (4) by Forsling from betanaphthylamine-α-sulphonic acid (the Badische acid); (5) by Erdmann and Kirchhoff from parachlorophenylparaconic acid. Forsling has quite recently stated (*Beriche*, 1888, 2802) that the modification melting at about 61° is either 1 : 2 or 1 : 3 dichloronaphthalene, his conclusion being doubtless based on Cleve's statement that dichloralphanaphthylamine yields phthalic acid on oxidation, and is therefore to be regarded as homonucleal. Now the authors have found (*British Association Report*, 1887, p. 231) that two distinct dichloronaphthalenes have been regarded as one, and that while that from dichloralphanaphthylamine melts at 61·5°, that from Arnell's β-chloronaphthylenesulphonic acid and from the Badische or betanaphthylamine-α-sulphonic acid melts at about 64°; the chloride of the acid obtained on sulphonating the former melts at about 148°, the isomeric sulphochloride obtained from the latter melting at 119°. In support of Cleve's statement that dichloralphanaphthylamine is a homonucleal compound, they are able to state that it yields the same trichloronaphthalene (m. p. 92°) as dichloralphanaphthol, an undoubted homonucleal derivative. The dichloronaphthalene melting at 61·5° is, therefore, either the 1 : 2 or the 1 : 3 homonucleal modification. That melting at 64° must be regarded as the 1 : 2′ or 1 : 3′ heteronucleal modification, inasmuch as the dichloronaphthalene melting at 34°, discovered by Cleve in 1887, is also a homonucleal compound.

The dichloronaphthalene melting at 34° was obtained by Cleve from chlorobetanaphthylamine and from chlorobetanaphthol; it may also be prepared from the chloralphanaphthylamine which Cleve obtained by reducing dichloralphanaphthylamine. Cleve's statement that chlorobetanaphthylamine is a homonucleal compound, since it yields phthalic acid on oxidation, is confirmed by the observation that a sulphonic acid may be prepared from chlorobetanaphthol, which is converted on treatment with bromine into a bromhydroxyquinonesulphonate, identical with that which may be obtained from Schæfer's betanaphtholsulphonic acid, in which the bromine is undoubtedly present in the quinone nucleus.

The fourth $\alpha\beta$ and the second heteronucleal dichloronaphthalene is the η-modification, melting at 48°. This was originally obtained by Cleve from one of the three α-nitro-derivatives of naphthalene-β-sulphonic acid; it has since been prepared by Forsling from betanapthylamine-γ-sulphonic acid (Dahl's modification), and synthetically by Erdmann and Kirchhoff. The authors have recently obtained it by distilling their ? β-naphthalenedisulphonic acid (*Abstracts of Proceedings*, 1886, p. 231) with phosphorus pentachloride; attention is to be called to the fact that this had previously been stated to be a method of preparing the θ-modification, melting at 61·5° (*Brit. Assoc. Report*, 1887, p. 232); how the mistake arose they are unable to explain, but a mistake was undoubtedly made, as a portion of the original specimen of the sulphochloride, melting at 150°, referred to in the British Association Report, gave on hydrolysis η- and not θ-dichloronaphthalene. The sulphochlorides prepared from the two dichloronaphthalenes melting at about 48° and 61° respectively have the same melting-point, and hence the mistake was overlooked until recently, when a large quantity of disulphonic acid was prepared and converted into dichloronaphthalene.

It being determined that the two modifications melting at 34° and 61·5° are the two possible homonucleal $\alpha\beta$-dichloronaphthalenes, it remains only to ascertain which is the 1 : 2 and which is the 1 : 3 compound; the authors have succeeded in solving this problem somewhat unexpectedly by studying so-called α-dichloronaphthalene, m. p. 38°, which is obtained an heating naphthalene tetrachloride with alcoholic potash. On sulphonating this compound, two isomeric sulphonic acids are formed, the chlorides of which melt at 133° and 148°, but as these are the melting-points of the chlorides formed from the acids which result on sulphonating β-dichloronaphthalene

(m. p. 68°) and θ-dichloronaphthalene (m. p. 61·5°) respectively, the two sulphochlorides from α-dichloronaphthalene were hydrolysed; *that melting at* 148° *gave* θ-, *and that melting at* 133° β-*dichloronaphthalene*, proving the supposed uniform α-dichloronaphthalene to be a to be a mixture of θ and β. From this it follows, as only a single $\alpha\beta$ homonucleal dichloronaphthalene can be obtained from naphthalene tetrachloride, viz., the 1 : 3 modification, that θ-dichloronaphthalene melting at 61·5° is the 1 : 3 derivative, and that melting at 34° must be regarded as the 1 : 2 derivative. This conclusion is supported by Widman's observation (*Bull. Soc. Chim.*, xxviii., 506; *Ber.*, 1882, 2160) that α-dichloronaphthalene yields two tetrachlorides — one an oil yielding γ-tetrachloronaphthalene, the second a crystalline solid melting at 172°, indistinguishable from that obtainable from β-dichloronaphthalene. It is also confirmed by the observation that on hydrolysing the dichloronaphthalenesulphonic acids prepared, in accordance with Widman's directions, from naphthalene-α- and β-sulphonic chlorides, θ-dichloronaphthalene, melting at 61·5, is obtained from the α-acid, and β-dichloronapthalene from the β-acid.

At present the data are not sufficient to determine whether the heteronucleal modification, melting at 48°, is the 1 : 3, and that melting at 64° the 1 : 2 derivative, or *vice versâ*. Erdmann and Kirchhoff have indeed put forward the view that η-dichloronaphthalene is the 1 : 3 modification, but their method cannot be regarded as trustworthy, as the origin of the hydroxyl in their naphthol derivatives cannot be determined. The authors anticipate that the study of the sulphonic acids of the dichloronaphthalenes, in which they have long been engaged, will lead to results which will permit of the constitution of isomerides such as the η and the isomeric heteronucleal $\alpha\beta$-dichloronaphthalenes being determined beyond question.

85. "*Piazine-derivatives.*" By Dr. Arthur T. Mason.

In this paper, which is an account of a continuation of work described in the *Berichte*, xx., 267, the author adopts Widman's nomenclature (*J. Pr. Chem.*, xxxviii., 135): the "Ketines" (V. Meyer), "Pyrazines" (Wolff, Mason), "Aldines" (V. Meyer), and all compounds containing a ring of four carbon-atoms and two nitrogen-atoms in para-position are now termed *Paradiazines* or *Piazines*.

The author finds that the condensation product obtained from phenanthraquinone and ethylenediamine is not a dihydride, as formerly stated, but the base *phenanthrapiazine*.

Diphenylpiazinedihydride, prepared from benzil and ethylenediamine, which is very unstable towards acids, gives on distillation a very stable base (2, 3) *diphenylpiazine*; this crystallises from 50 per cent alcohol in large colourless plates, melting at 118—119°; it is only a weak base. The chloroplatinate, $C_{16}H_{12}N_2,PtCl_6$, forms long yellow prismatic needles.

By the action of sodium on a solution of 2, 3 diphenylpiazine in amyl alcohol, two hydrides were obtained of the formula $C_{16}H_{18}N_2$. α (2, 3) *Diphenylpiazinehexhydride* crystallises from light petroleum in long slender white needles, melting at 122—123°, and possesses strong basic properties. The *hydrochloride*, $C_{16}H_{18}N_2{\cdot}2HCl$, forms long glistening white needles, melting at 310°. The *chloroplatinate*, $C_{16}H_{18}N_2H_2PtCl_6+\frac{1}{2}H_2O$, forms golden-yellow prismatic needles. The *nitroso-derivative*, $C_{16}H_{16}N_6O_4$, crystallises in white prismatic needles melting at 142—143°. Methyl iodide gives with the α-hydride the *hydriodide of* (1, 4) *dimethyl* (2, 3) *diphenylpiazine tetrahydride*, $C_{18}H_{22}N_2HI$, which forms long colourless needles; the base of this salt crystallises from hot water in long colourless needles melting at 263—264°; the *chloroplatinate*, $(C_{18}H_{22}N_2)_32HCl(PtCl_4)_2+8H_2O$, forms yellow prismatic needles. β (2, 3) *Diphenylpiazinehexahydride*, which is found in the mother-liquors from which the α-compound has separated, together with a third basic hydride, crystallises from 50 per cent alcohol in long silky white needles, which on drying become dull white. It melts at 108—109°, and has strong basic properties. The *hydrochloride*, $C_{16}H_{18}N_22HCl$, forms colourless prismatic needles, melting at 295°. The *chloroplatinate*, $C_{16}H_{18}N_2{\cdot}2HClPtCl_4+2H_2O$, forms long light yellow needles. On oxidation (2, 3) diphenylpiazine yields a *phenylpiazinecarboxylic acid*, melting at about 202°, which yields well-characterised salts.

The author, in conjunction with Mr. L. A. Dryfoos, is extending the research to the α-diketones of the fatty series.

At the next meeting, on December 6th, there will be a ballot for the election of Fellows, and the following papers will be read: —

"A Method of determining Vapour-densities applicable at all Temperatures and Pressures." By Dr. W. Bott.

"Derivatives and Some New Colouring-matters obtained from α-Pyrocresol." By Dr. W. Bott and J. Bruce Miller.

"The Action of Ammonia on Tungsten Oxychlorides." By Dr. S. Rideal.

PHYSICAL SOCIETY.

November 24, 1888.

Prof. Reinold, President, in the chair.

The Rev. T. Pelham Dale and Dr. R. M. Walmsley were elected members of the Society.

Capt. Abney read a paper "*On the Measurement of the Luminosity of Coloured Surfaces*," which was illustrated by experiments.

In a communication to the Royal Society General Festing and the author have described a method of comparing the intensity of the light of different parts of the spectrum reflected by various pigments with that reflected from white; and luminosity curves have been constructed, the areas of which give comparative measures of the total luminosities. This method of comparison is accurate, but requires considerable time, and the author has devised a more rapid process. The coloured surface, whose luminosity is to be compared with white, is placed beside a white patch within a dark box. A direct beam of light passes through an aperture in the box, and a black rod casts a shadow on the coloured patch; another beam from the same source is reflected at an angle, and forms a shadow of the same rod on the white patch, the junction of the two shadows coinciding with that of the two surfaces to be compared. In the path of the direct beam is placed a rotating disc with angular openings, adjustable whilst rotating by a simple lever, and by this means the white patch can be made to appear too light and too dark in rapid succession. By gradually diminishing the range of oscillation of the lever, a position of equal luminosities can be found. The coloured surface is now replaced by a white one, and the adjustment again made, and from the angular apertures required in the two cases the relative luminosities are determined.

Comparisons made in this way (the numbers relating to which are given in the paper) with emerald green, vermillion, French ultramarine, &c., gave results in close agreement with those deduced from the luminosity curves obtained by the spectrum method.

In reply to questions, Capt. Abney said the spectrum method was the more accurate, and could be relied on to one per cent. The new method gave results within two per cent, showing that the eye is very sensitive to small changes of luminosity when such changes take place in rapid succession.

Prof. Rücker made a communication "*On the Suppressed Dimensions of Physical Quantities.*"

In arranging a system of dimensional equations for thermal quantities, the question arises as to what are the

dimensions of temperature. A degree of temperature as measured by the ordinary arbitrary method of the mercurial thermometer, is not affected by changes in the units of length, mass, and time, but the numerical values of thermal quantities (J for instance) depends on the scale of temperature adopted, say Centigrade or Fahrenheit. Two courses seem open, either of which renders a complete system of thermal dimensional equations possible. 1st, Temperature may be considered as a measure of energy, as in the kinetic theory of gases, and may be expressed as the energy of translation of a standard number of molecules, say that number contained in 1 c.c. of air at standard pressure and temperature; or 2nd, Temperature may be considered as a secondary fundamental unit. If the first be adopted, the dimensions of specific heat become M^{-1}, and the temperature of 0° C. is expressed by $1{\cdot}5207 \times 10^6$ ergs. If a practical unit corresponding to $\frac{10^8}{18}$ ergs be adopted, this new unit of temperature will coincide with the Centigrade degree to about 1 part in 3000. The chief objection to such a definition of temperature is that the above relation between temperature and energy is not yet proved to hold for liquids and solids. If the second course be adopted the dimensions of all thermal quantities may be expressed in terms of M, L, T, and θ, where θ is the unit of temperature.

Attention was directed to the difficulties students generally experience on finding the dimensions of the same electrical quantities to be different, according as they are expressed in electro-static or electro-magnetic measure, and that different quantities may have the same dimensions. The anomalies are shown to be due to the suppression of the dimensions of specific inductive capacity and permeability, each being called unity in air. By retaining K and μ in the dimensional equations the author thinks that many difficulties will be avoided, the methods of transformation of units will be generalised, and the limits of our knowledge kept more clearly in view. Though the dimensions of K and μ cannot be determined, it is easily shown that those of the product $K^{\frac{1}{2}} \mu^{\frac{1}{2}}$ are $L^{-1} T$.

Mr. Blakesley, in commenting on thermal units, strongly protested against the use of the word "*Therm*" as a name for the unit of heat. If used at all, it should be reserved for the unit of temperature. Referring to the choice of fundamental units, he reminded the Society that the dimensions of quantities expressed in the electrostatic or electro-magnetic systems become identical if the unit velocity be the velocity of light, and by choosing the unit of time as a suitable decimal part of a day, the relations between electrical and practical mechanical units could be simplified.

Prof. Carey Foster, after discussing the effects of defining specific heat as a ratio, or as a quantity of heat on the dimensions of temperature, pointed out that as Quantity of heat = Temperature × Entropy, the dimensions of temperature would be determinate if those of entropy were found.

Prof. S. P. Thompson considered part of the difficulties of dimensional equations arose from the fact that no distinction was made between *scalar* and *vector* quantities. Thus the dimensions of work and moment of a force are given as $M L^2 T^{-2}$, whereas the true representation for the latter would be $M L^2 T^{-2} \sqrt{-1}$, because the line by which the force is multiplied is at right angles to the force. By similar considerations, Ampére's rule for the force between two current elements, can be derived from the magnetic equation $\frac{m.m'}{r^2} = f$. For replacing m and m' by equivalent current elements, $i.ds$ and $i.ds'$, the equation becomes—

$$\int = \frac{\sqrt{-1}\, i.ds \,.\, \sqrt{-1}\, i.ds'}{r^2}$$

$$= \frac{-i^2 ds.ds'}{r^2}$$

Referring to the use of *Therm*, Dr. Thompson concurred with the remarks of Mr. Blakesley, and thought the word "*calorie*" answered all requirements. He also considered that thermal equations were greatly simplified by always expressing specific heat in ergs.

Prof. Ayrton was of opinion that students experienced much greater difficulty in dealing with electrical units than with thermal ones, and thought part of this was due to the vague way in which some of the standard text-books treated the subject. With reference to the force exerted by quantities of electricity, Prof. Perry and himself had pointed out that specific inductive capacity must be taken into account, for, contrary to Faraday, they had found it to be different in different gases.

In reply, Prof. Rücker said he often explained the identity of the dimensions of work and moment of a force, by considering moment as measured by the work done in rotating through unit angle, the dimensions of angle being zero as regards L, M, and T. He also pointed out that in Bayne's Thermodynamics specific heats are always expressed in ergs.

In thanking Prof. Rücker for his interesting paper, the President expressed his conviction that by paying attention to the points considered, the difficulties arising from the two systems of units would be considerably diminished.

OBITUARY.

DR. WALLACE.

The death of Dr. Wallace, of Glasgow, which took place on the 5th inst., removes one of our most eminent and successful technical chemists. The deceased *savant* was generally recognised as an authority on sanitary questions, such as water supply, the air of towns, the disposal of sewage, the preservation of food, the hygienic construction of houses, and the germ-theory of putrefaction. But it is, perhaps, less widely known that he was an eminent expert in all questions connected with the manufacture, the analysis, and the utilisation of coal-gas. In the years 1868 to 1877 he was engaged in analysing gas-coal and in testing its practical value. His researches extended to upwards of 200 samples of Scottish coals, cannels, splints, and shales, as well as to similar minerals from Australia and from the United States and other foreign countries. He also studied very carefully the heating power of gas, gas-meters and governors, gas-burners, and lamps. Among other points, he established the fact that gas of low illuminating power is the most economical as a source of heat. Prior to the year 1876, Dr. Wallace was also busied with investigations bearing on the Scottish iron manufacture, and he made upwards of 2000 analyses of the raw materials, iron-stones, lime-stones, fire-clays, and furnace coal, as well as of the pig-iron and slags produced.

For many years he was also engaged in a study of the principles of sugar-refining, in which he was accepted as a leading authority.

The deceased chemist was a Fellow of the Royal Society of Edinburgh, of the Chemical Society, and of the Institute of Chemistry. He was for many years connected with the Glasgow Philosophical Society, the Presidency of which he held for three years. He was also an active member of the Society of Chemical Industry.

We must add that Dr. Wallace was no less esteemed in his private life than in his scientific and technical capacity.

JOHN COLLINS.

We regret to announce the death, on the 28th of August last, of one of the most prominent chemists in Lancashire, Mr. John Collins, B.A., F.C.S., F.I.C., F.G.S., of Messrs.

Collins, Analytical Chemists and Consulting Chemical Engineers, Bolton, near Manchester. Mr. Collins was born in 1832 at Darton, in Yorkshire. He was educated at Chester College; and to the late Rev. Arthur Rigg, M.A., Mr. William Crookes, F.R.S., and South Kensington, he was indebted for his early scientific training. He was at one time Borough Analyst and Gas Examiner, and also Chemist to the Bolton Iron and Steel Co.; and while holding the latter position he worked out to a successful issue the Siemens-Martin and Bessemer processes. In the earlier years of his professional life he devoted much time to metallurgical matters; and he carried out a series of experiments on a most elaborate scale on the corrosion of steel and iron plates. He gave up his post as manager of the extensive steel work of the Bowling Iron Co. to continue his practice in Bolton. His profound knowledge of chemical and metallurgical work, together with his practical intimacy with engineering, metallurgical, and trade processes, generally secured him an extensive practice, and his opinion on patents, new processes, and so forth, was largely sought after.

Some twenty years ago he devoted special attention to water supply and pollution and sanitary matters, and in this branch of work he made a reputation. He patented a process for treating towns sewage called the "M and C Process"; this has been used for many years at Bolton and elsewhere with satisfactory results. His experience in litigation as an expert witness was very extensive, and he was a familiar figure in the committee rooms at Westminster and also the New Law Courts. He was an excellent lecturer, and had taken out, in association with his son, Dr. Walter H. Collins, many patents for improvements in trade operations.

Those who were intimate with him will find it difficult to name a man more equally or usefully accomplished. He had read deeply, and had observed men and manners in many countries.

NOTICES OF BOOKS.

An Essay on Cramming. By R. W. Davey and R. H. Thompson. London: John Walker and Co.

The authors of this essay, like ourselves, regard the modern English system of competitive examination with dislike and suspicion. But, concerning the process commonly known as "cramming," and without which they rightly pronounce success almost impossible, they take a view, novel indeed, but which merits a fair scrutiny. It is commonly supposed that this cramming process is a great evil, and that crammers are an institution the country could very well do without. The authors, on the contrary, argue that the competitive examinations are the evil created by pedantic legislators, and that cramming is the remedy supplied by the common sense of the public. In this view there is, at least, a very considerable element of truth. They remind us that:—"The Civil Service Examiners, if left to themselves, would fill the Indian Service with decrepit students, unable to endure for a year the strain of real work in a trying climate; the crammer baffles them by his skill, enabling at least some men, of more vigorous nature, to obtain entrance. The examiners would crush out all originality and force beneath a solid weight of useless and musty learning; the crammer substitutes a structure so like the reality that it deceives the common enemy, but built of such light and airy materials that the moment the ordeal is passed it begins to dissolve into thin air, and the candidate is gradually able to recover his suspended animation and release his trammelled faculties. The examiner would reduce us in one generation to the condition from which China is only just beginning to awake; the crammer preserves for us some, at least, of the powers to which we owe our existence as a nation, and our position as rulers of an empire."

We must remember that intellectual work, even of the most intense character, is not injurious, save when it is performed under the pressure of anxiety. But the unfortunate candidate who is preparing for an examination must be anxious, since a failure may ruin his prospects for life. Hence the effect upon the health of the student, successful or not, is ruinous.

Another point quite overlooked by the dominant pedantocracy is that examination may test a man's attainments, but not his powers; it may show us what he knows, but not what he can do. Now, save for the merest routine work — for which competent men might be obtained by lot—the great question is what a man can do. What are his resources, his power of origination? This is what we want in the civil administrator, in the military or naval officer, in the physician, the explorer, and the industrialist. But what reason have we to expect that the man who "passes" best—or passes at all—in a number of subjects, many of them quite irrelevant to his future life duties, will excell in suggestiveness? We fear that originality will be inversely as the power of "getting up" a given subject.

One remark of the author's deserves approving notice:—"Hitherto no editor has conceived it his duty to review the Examination Papers issued periodically by the Civil Service Commissioners, and to point out how a public interest so vital as the selection of our future officers is frequently left to the mercy of men whose chief object seems to be the display of their own erudition and the gratification of their own crotchets."

Of the remedial measures proposed by the authors, the following are important: — Direct responsibility of examiners and public criticism of their work, as also an imperative demand on part of the nation that absurd subjects, such as Latin and Greek verse, should be at once struck out. Poetry is an affair for one man in a million, and should not be required of others. But verse which is not poetry is beneath all contempt. Many other subjects demanded at examinations are little less absurd for the particular class of candidates in question.

Two further reforms Messrs. Davy and Thompson have overlooked, viz., the abrogation of "payment by results" in all grades of education, and the admission of original work as overriding all other considerations.

A New Course of Experimental Chemistry, including the Principles of Qualitative and Quantitative Analysis: Being a Systematic Series of Experiments and Problems for the Laboratory and Class-Room. By John Castell-Evans, F.I.C. London: Thomas Murby.

In this book, which is one of Murby's "Science and Art Department Series" of text-books, the author makes some "introductory remarks" of considerable value. He tells us that "if he had simply added another to the so-called Text-Books in Chemistry, he would require considerably more ingenuity than he possesses in order to be able to make a suitable apology for such a very unnecessary proceeding." He goes on to say that "something was wanting which could not be supplied by any text-book or any practicable combination of existing books." Now this is what all the authors of text-books tell us explicitly or implicitly. They admit the multiplicity of existing elementary treatises, but they believe that something is wanting which they see the way to supply.

We certainly recognise that Mr. Castell-Evans proposes a course of instruction very different from those commonly adopted. He shows a full and clear acquaintance with the processes of experimental enquiry, and he seeks to train the student "to perform a quantitative experiment with a definite purpose in view." He tells us, most truly, that the best trained student is not he who has hoarded up the largest number of truths, but rather that one who

has become most expert in the use of the methods and means by which truths are found out." And in these few words he does in effect pronounce judgment on the system of "payment by results" (so-called), and on examinationism altogether. For no examiner can gauge the power of a pupil to find out truths; all he can do is to measure what quantity of knowledge he has accumulated. Our author refers to the Committee appointed by the British Association to inquire into the methods adopted for teaching chemistry. If this Committee will only say "drop payment by (pseudo-) results and let teachers no longer be hampered with the haunting nightmare "will such a method of instruction *pay*?" we shall soon see spring up, in place of our present examinees, a rich crop of discoverers, inventors, and appliers.

The instructions given in this book show a laudable attention to accuracy in every point.

CORRESPONDENCE.

ALKARSIN.

To the Editor of the Chemical News.

Sir,—I find that alkarsin (the mixture of the oxide with free kakodyle) is much more quickly prepared, and more easily, by distilling a mixture of white arsenic and carbonate of potash with glacial acetic acid than by the old slow method of distilling the white arsenic with acetate of potassium, which necessitates carefully heating the retort (otherwise it will break, the contents being dry) to redness.

The white arsenic will not decompose the acetic acid by itself; it must be in the presence of the carbonates, so that the moment the acetic acid and the carbonate decompose each other the arsenic may enter and combine with the methyl, partly in the form of kakodyle and partly in the form of its oxide, the mixture of the two, as is well known, forming alkarsin.

Is cyanide of kakodyle formed by distilling a mixture of white arsenic and *sodium* cyanide with glacial acetic acid?

I have since found that arsenious cyanide, $As(CN)_3$, is *not* formed by distilling one part metallic arsenic with six of mercuric cyanide, but only by the reaction of arsenious chloride on some cyanide; the cyanogen does not seem to combine *directly* with arsenic any more than it does with hydrogen, and perhaps that is the reason that cyanide of arsenic has not been previously discovered.—I am, &c.,

G. W. Blythe.

12, Walmer Road, Birkdale,
near Southport, Nov. 25, 1888.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 20, November 20, 1888.

The Nature of Milk. Reply to the Question:—"Does Milk Contain the Anatomical Elements of the Organisation, and do the Globules of Milk Rank among these Elements?"—A. Béchamp.—The author concludes that milk is not an emulsion. The milky globules are not bare globules of fat, but true free adipose vesicles. The milk of the cow contains, in addition to casein, other albumenoid matters not free, but dissolved in combination with alkalies. Milk curdles spontaneously without the intervention of vibrios.

The Siliceous Compounds of Glucina.—P. Hautefeuille and A. Perrey.—In its combinations with silicon and potassium, glucina is replaced in all proportions by the alumina and ferric oxide, playing thus the part of a sesquioxide. In other compounds glucina acts as a protoxide.

Presence of Glycolic and Normal Propylene Dicarbonic Acid in Suint.—A. and F. Buisine.—Not adapted for useful abstraction.

Bulletin de la Société Chimique de Paris. Vol. l., Nos. 4 and 5.

Action of Copper Acetylacetonate upon Carbon Oxychloride.—MM. Thomas and Lefévre.—The authors have not yet decided whether the result of the reaction is tetracetylacetone or dimethyldiacetyl pyrone.

On Allotropic Arsenic. A Reply to Prof. Geuther.—M. Engel.—The molecular constitution of ordinary arsenic and that of the allotropic state appear to be respectively the same as those of red and white phosphorus. The specific gravity, 3·7, given by Prof. Geuther for allotropic arsenic is incorrect, and consequently the conclusions which he draws from this datum have no foundation.

The Volumetric Determination of Acids.—M. Engel.—In this note the author brings a claim to priority as regards the method proposed by M. Lenossier for the separation and volumetric determination of acids.

The Part played by Soda-lime in the Determination of Nitrogen.—M. Quantin.—The soda-lime process can yield good results provided we ignite rapidly and gently, and that only half the acid is saturated by the ammonia evolved.

Researches on the Sulphines.—G. Patein.—Not adapted for useful abstraction.

Acid Sulphates of Dimethylaniline and Diphenylamine. A General Reaction of the Acid Sulphates of Certain Aromatic Bases.—Leo Vignon.—The author describes dimethylaniline acid sulphate, dimethylaniline monosulphonic acid, diphenylamine acid sulphate, diphenylamine-monosulphonic acid, and discusses the formation of the acid sulphates of aniline, dimethylaniline, and diphenylamine. The formation of the mono-sulpho-conjugated acids of dimethylaniline and diphenylamine, obtained by heating the acid sulphates of these bases to 180° to 190° for two hours, seems to constitute a general reaction. Acid aniline sulphate, under the same conditions, is transformed almost quantitatively into sulphanilic acid or aniline monosulphonic acid. This reaction is applied industrially for the preparation of sulphanilic acid. It seems therefore that the acid sulphates of aniline, and of the substituted amines derived from it, lose water at 180° to 190°, forming sulphonic derivatives.

The Production of Propylene Iodide in the Treatment of Glycerin with Iodine and Phosphorus.—H. Malbot.—The author, using red phosphorus, obtained a product which, when washed directly with soda without cohobation, had a volume of 135 c.c., and the density of 1·725. The proportions used were iodine, 300 grms., glycerin (sp. gr. 1·25), mixed with an equal volume of water, 200 grms., and phosphorus, 55 grms. The product was rich in isopropyl iodide. On adding only 10 per cent of water to the dry glycerin, the product obtained had the volume of 127 c.c. and the sp. gr. 1·99. It turned black very rapidly, even in the dark, and was very rich in propylene iodide.

Preparation of Epichlorhydrine.—Ad. Fauconnier.—Not suitable for abstraction.

Preparation of Ethylene Cyanide.—Ad. Fauconnier.—Three hundred parts of ethylene bromide are dissolved in 500 parts of alcohol, and the solution is boiled in a

reflux-apparatus. When it is a full boil, 200 parts of potassium cyanide in a saturated watery solution are let fall into it drop by drop. Each drop causes a precipitate of potassium bromide, and the reaction is completed in less than two hours. It is then let cool, the liquid poured off, and evaporated to dryness in vacuo on the water-bath. The residue is taken up in absolute alcohol and this alcoholic solution is distilled at first on the water-bath, then in the open fire, and in vacuo.

On Metallic Lustre.—W. Spring.—A metallic lustre is produced whenever a smooth surface is formed on a body sufficiently opaque. The more complete the opacity and the more perfect the smoothness of the surface, the more decided is the metallic lustre. But as there is probably no body absolutely transparent, so there is no body absolutely opaque. All depends on the degree of thickness in which we examine the substance. Between the vitreous lustre and the perfect metallic lustre there are all the gradations between transparence and opacity. Hence the metallic lustre does not in any way depend on the specific chemical nature of the substance, but on its physical condition.

Researches on the Glazes of Porcelain.—Ch. Lauth and G. Dutailly.—This valuable memoir does not admit of abstraction.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. Series 5, Vol. iii., No. 28.

This number contains no chemical matter.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Potassium Permanganate.—Can anyone inform me where to find the decision arrived at with regard to the molecular formula for potassium permanganate (*i.e.*, whether $KMnO_4$ or $K_2Mn_2O_8$) by Raoult's cryoscopic method?—F. W. S.

Estimation of Oxygen in Metallic Copper.—Is this method known? I believe it is only a modification of Abel's. A weighed portion of the copper is immersed in a solution containing 30 grms. of nitrate of silver for four hours; at the end of this time the Cu is washed and withdrawn, the precipitate separated by filtration, and the amount of silver remaining in the filtrate determined gravimetrically.—Chemicus.

MEETINGS FOR THE WEEK.

Monday, 3rd.—Medical, 8.30.
— Society of Arts, 8. (Cantor Lectures). "Light and Colour," by Capt. W. de W. Abney, F.R.S.
— Royal Institution, 5 General Monthly Meeting.
— Society of Chemical Industry, 8. "Analytical Examination of Water for Technical Purposes," by A. H. Allen.
Tuesday, 4th.—Institute of Civil Engineers, 8.
— Pathological, 8.30.
Wednesday, 5th.—Society of Arts, 8. "The Graphophone," by Henry Edmunds.
— Geological, 8.
Thursday, 6th.—Royal, 4.30.
— Royal Society Club, 6 30.
— Chemical, 8. Ballot for the Election of Fellows. "A Method of Determining Vapour Densities applicable at all Temperatures and Pressures," by Dr. W. Bott. "Derivatives and some New Colouring Matters obtained from α-Pyrocresol," by Dr. W. Bott and J. Bruce Miller. "The Action of Ammonia on Tungsten Oxychlorides," by Dr. S. Rideal. "On Thionyl Thiocyanate," and on "Mercuric Chlorothiocyanate," by G. C. McMurtry.
Friday, 7th.—Geologists' Association, 8.
Saturday, 8th.—Physical, 3. "On some Facts connected with Systems of Scientific Units of Measurement," by T. H. Blakesley.

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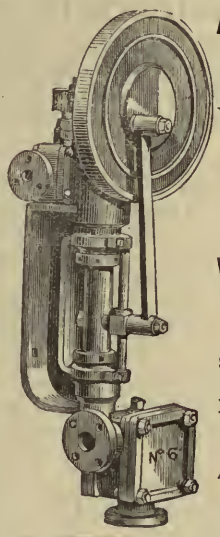

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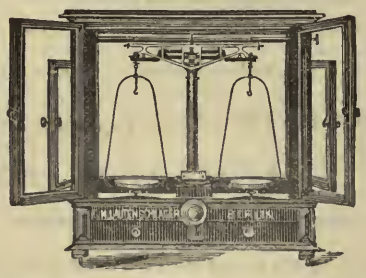

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1515.

ON THE SPECIFIC HEATS OF GASES AT CONSTANT VOLUME.*

(Preliminary Note).

By J. JOLY, M.A., B.E.

I have found it possible to obtain the specific heat of a gas at constant volume by means of the steam calorimeter,† the values obtained being, I believe, reliable as close approximations to the true values.

The first method of procedure adopted was to compress by means of a pump a certain quantity of dry air into a thin copper sphere, the sphere being then closed by a screw valve. The quantity of gas in the sphere is ascertained by weighing.

The sphere is now hung in the calorimeter, suspended from a delicate balance, reading to one-tenth of a m.grm., and its thermal capacity determined in a certain number of experiments. The gas is then released, and the sphere further exhausted by means of an air-pump, sealed, and its thermal capacity again determined in a number of experiments. This allows of a computation of the thermal capacity of the contained gas.

This method I at first used, but, as in dealing with the effect on the weighings, due to the transference of so bulky a body from air to steam, much troublesome calculation and risk of error was involved, I modified it in the following manner:—

Two spheres are prepared, alike with respect to external volume, and approximately of the same weight. The thermal capacities of these are compared in a double calorimeter, being suspended one from each arm of a short beam balance. If their thermal capacities are not alike a calculated weight or copper wire is introduced into that of least thermal capacity. They are in this way brought to have the same thermal capacity, so that in an experiment on the empty spheres there is no effect on the balance.

One of these is now pumped full of air, and the specific heats of the spheres again compared. The weight of condensation now obtained is that due to the gas alone. It is evident that many sources of error obtaining in the former method are removed in the latter. The results obtained are also far more consistent one with another. In this case the specific heat is calculated directly on the formula given in my paper on the steam calorimeter—

$$S = \frac{w\lambda}{W(t_2 - t_1)},$$

where λ is the latent heat of steam, w the weight of steam condensed by the gas, W the weight of gas, and t_2 t_1 the extremes of temperature obtaining. S so calculated may be subject to some slight corrections, which I will not here enter into.

Up to the present I have only dealt with air, but I have made preparations for resuming shortly my work, dealing with other gases, over critical temperatures, if possible, in some cases, and making confirmatory experiments on air and also in extension of those given below.

The spheres used are about 6·7 cm. internal diameter; volume 158·5 c.c. They weigh about 92·2 grms. That containing the air is tested hydraulically to 1000 lbs. per square inch.

Table I.

Weight of Air in the Sphere = 5·4816 grms.
Pressure at 100° C. about 27,700 m.m. of Mercury.
Density $= \frac{W}{V} = 0{\cdot}03458$.

No.	t_1.	t_2.	λ.	w.	Sp. heat.
1.	14·93	100·24	536·3	0·1536	0·17615
2.	16·52	100·17	536·4	0·1507	0·17629
3.	14·94	100·15	536·4	0·1547	0·17766
4.	16·28	100·15	536·4	0·1513	0·17653
5.	15·18	100·22	536·4	0·1550	0·17835
			Mean		0·17699

Table II.

Weight of Air in the Sphere = 4·3084 grms.
Pressure at 100° C. about 21,800 m.m. of Mercury.
Density $= \frac{W}{V} = 0{\cdot}027182$.

No.	t_1.	t_2.	λ.	w.	Sp. heat.
1.	16·10	100·22	536·4	0·1194	0·17672
2.	15·20	100·33	536·3	0·1222	0·17868
3.	16·88	100·33	536·3	0·1182	0·17631
4.	15·20	100·15	536·4	0·1199	0·17572
5.	16·69	100·12	536·4	0·1188	0·17728
			Mean		0·17694

Table III.

Weight of Air in Sphere = 3·1357 grms.
Pressure at 100° C. about 15,890 m.m. of Mercury.
Density $= \frac{W}{V} = 0{\cdot}019784$.

No.	t_1.	t_2.	λ.	w.	Sp. heat.
1.	15·88	100·07	536·5	1·0870	0·17680
2.	16·69	100·06	536·5	0·0853	0·17506
3.	16·43	100·04	536·5	0·0876	0·17926
			Mean		0·17704

These, it is seen, afford a result above that theoretically assigned to air at constant volume (0·1684). They differ too somewhat from some experiments made by the first-described method, are somewhat lower than their mean, but the consistency displayed throughout in the thirteen experiments given, especially in Tables I. and II., leads me to give these numbers as probably a close approximation to the true value. One point is at any rate brought out clearly, that is, that the surmise that the specific heat of a gas at constant volume was a quantity independent of pressure—a surmise based partly on the constancy of the specific heat at constant pressure—would appear to be correct. The values in the three tables, calculated simply on the weights of gas dealt with in each set of experiments, show results quite independent of the great variations of pressure and density obtaining, the weight of condensation simply falling off with the decrease in the weight of gas, till in the third table w is beginning to feel the errors incidental to the considerable mass of the spheres and to give more variable results. I have prepared very thin light spheres with a view to continue the experiments to lower pressures with less danger of error.

The cause of the excess in the value obtained above the theoretical is not apparent, especially in view of the independence of pressure displayed. The experiments embodied in the three tables were made indeed upon the one sample of air—some being liberated after the first five experiments, and so on—but this had been dried through three calcium chloride tubes and two large U-tubes of phosphorus pentoxide before passing into the pump. Between the pump and the sphere it passed through a brass tube stuffed with asbestos which had been previously

* Read before the Royal Society, November 22nd, 1888.

† "On the Method of Condensation in Calorimetry" (by J. Joly), *Roy. Soc. Proc.*, vol. xli., p. 352; and "Ueber das Dampfcalorimeter" von R. Bunsen), *Wiedemann's Annalen*, vol. xxxi., p. 1.

heated to redness. The object of this is to guard against oil being carried from the pump into the sphere.

My first determination of the specific heat of air at constant volume was effected on the 13th of April of this present year. It was made by the method described in the beginning of this note at a pressure somewhat higher than that at which the experiments of Table I. were effected. This experiment gave as a result the specific heat of air to be 0·17565.

NOTE. OCTOBER 18.

Subsequent more extended experiments have shown me that this condition was not absolutely fulfilled. A small reduction of the values recorded for the specific heat of air is necessary on this account, but insufficient to effect any remarks made in this note. Successive experiments on the empty spheres, I may observe, are sufficiently consistent one with another to warrant the assumption that the values recorded by me are not probably affected to the extent of one per cent by errors on the calorific capacities of the spheres.

PRELIMINARY NOTE ON A SILICO-ORGANIC COMPOUND OF A NEW TYPE.*

By J. EMERSON REYNOLDS, M.D., F.R.S.,
Professor of Chemistry, University of Dublin.

THE subject of this note is a fine crystalline substance, and is the first well-defined compound yet known in which we have reason to believe that silicon is in direct and exclusive union with the nitrogen of amidic groups. Its analysis and mode of formation lead to the conclusion that it is *silicotetraphenylamide*,

$$Si\begin{cases}NHC_6H_5\\NHC_6H_5\\NHC_6H_5\\NHC_6H_5\end{cases}.$$

This body is produced when silicon tetrabromide (or the tetrachloride) is added to excess of aniline, diluted with three or four volumes of benzene. Aniline hydrobromate (or hydrochlorate) is a secondary product of interaction and separates, being insoluble in benzene. If aniline be in excess throughout the operation, the whole of the halogen precipitates as aniline salt, and there remains in solution impure silicotetraphenylamide. If aniline be not in excess, a bromo-compound is obtained analogous to Harden's rather ill-defined chlorinated product.

Distillation from a water-bath readily removes benzene from the solution, and a liquid remains which solidifies after some time to a yellowish mass. The latter dissolves in warm carbon disulphide, leaving a residue containing some thiocarbanilide, and cautious evaporation of the solution leads to the separation of magnificent crystals of the silicon compound. These form chiefly at the surface of the liquid, as they are specifically lighter than the solution.

When twice re-crystallised from carbon disulphide, the substance is obtained in a state of purity.†

The crystals of silicotetraphenylamide are perfectly colourless short prisms of considerable size. They melt at 136—137° to a transparent liquid, which can be heated to 210° without decomposition. On cooling, this liquid solidifies to a transparent glass, which, like the original crystals, can be easily decomposed by water.

If silicotetraphenylamide be heated under diminished pressure (about 80 m.m.), it affords a distillate of aniline, and leaves a residue which seems to be the silicon analogue of *carbodiphenylimide*; but the latter has not yet been completely analysed.

The detailed investigation of the new substance and its derivatives is in active progress, and promises to throw light on the hitherto obscure relations of silicon and nitrogen.

I have reason to believe that the homologues of aniline, and certain other analogous nitrogen compounds, act like excess of aniline on the silicon haloids, and produce substances similar to the subject of this note. These reactions are also being investigated in my laboratory.

* Read before the Royal Society, Nov. 22, 1888.

† A large quantity was prepared in June last, and about 50 grms. of the pure compound were exhibited on September 11th in Section B during the meeting of the British Association at Bath.

NOTE ON THE

DETERMINATION OF COPPER BY THE IODIDE PROCESS.

By ROWLAND WILLIAMS, F.I.C., F.C.S.

As there appears to be considerable difference of opinion concerning the value of the iodide process for the determination of copper—certain metallurgical chemists having raised objections to its use, while, on the other hand, Mr. Westmoreland regards it with great favour—I thought it worth while to try the method in estimating the percentage of copper in two samples of sheet copper which I recently had occasion to examine.

According to Sutton ("Volumetric Analysis," 4th Edition, p. 142), the iodide process is principally available for the rapid estimation of small quantities of copper, and the results are accurate in the absence of per-salts of iron and other reducible substances.

Fresenius, who, by the way, claims that the process was devised in his laboratory by De Haen, employs a sulphuric acid solution of the copper. Fresenius says ("Quantitative Analysis," 7th Edition, p. 259) the results are accurate if the copper solution be free from sesquioxide of iron, free nitric and hydrochloric acids, and other bodies which decompose iodide of potassium. He also remarks that the solution, after adding the potassium iodide, must not be allowed to stand too long before titration.

My estimations were made by dissolving 63 grains of each sample in the theoretical amount of dilute nitric acid, boiling off nitrous fumes, adding carbonate of soda solution until a slight permanent precipitate appeared, then acetic acid in slight excess, and making up to 10,000 grains. One-tenth of the whole (=6·3 grains of the sample) was measured off for each titration, excess of potassium iodide added, and, after allowing to stand a few minutes, titrated with decinormal hyposulphite solution. This mode of procedure is essentially the same as that adopted by Mr. Westmoreland, excepting the strength of the hyposulphite solution, which, for convenience sake, I make decinormal.

When an aliquot portion equivalent to 6·3 grains of the sample is taken, and decinormal hyposulphite used, if the number of grains of hyposulphite employed in each titration be divided by ten, the percentage of copper is at once indicated. In the case of the two samples of copper under consideration, the iodide process yielded results very similar to those obtained by the method which I usually employ. The iodide process is undoubtedly both expeditious and accurate in the case of refined copper or pure copper solutions, but certain impurities, especially lead, iron, and arsenic, seem to exert a prejudicial effect. Ferric salts in particular invariably cause the results to be inaccurate. In his original paper on this subject (*Journal of the Society of Chemical Industry*, vol. v., p. 52), Mr. Westmoreland says he is inclined to think that ferric acetate liberates iodine from potassium iodide. I have proved by actual experiment that this is the case,

and the same remark applies to ferric nitrate. Ferric acetate equal to one-tenth of a grain of iron, acting on potassium iodide solution acidified with acetic acid liberated 0·0508 grain of iodine in five minutes. Under the same conditions, ferric nitrate equal to one-tenth of a grain of iron liberated 0·0635 grain iodine. I also find that arsenic acid quickly decomposes potassium iodide to an estimable extent.

It may, of course, be argued that traces only of these impurities are likely to be present in liquids in which the copper is to be estimated by the iodide process, as the operator would have separated the copper in a fairly pure form, previous to titration. It is advisable, however, to call special attention to these possible sources of error.

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WATER SUPPLY TO STEAM BOILERS.

By THOMAS T. P. BRUCE WARREN.

It is a common practice to use waste steam for heating water before injecting into a boiler; in most cases the exhaust steam from the cylinder is condensed, and flows back again into the boiler. If the cylinder be lubricated with a compound oil containing a saponifiable oil or fat, serious consequences are likely to result, in consequence of "pitting" of the plates. Although this is so well known, I am not aware of any published statement on the chemistry of this subject.

A few years ago a sample of water drawn from a boiler was said to contain grease. Both the water and deposit from the boiler were repeatedly examined, with negative results. A sample of *scum* collected from the surface of the water was subsequently examined in the following way:—

A weighed quantity of the dried scum was digested in warm dilute HCl; the solution, on cooling, was coated with a dirty, unctuous film. On filtering and washing, the soiluble matter was removed, the dried residue was treated w th CS_2, which, on evaporation, yielded four per cent of a white solid fat, consisting principally of stearic acid.

As these earthy soaps float, they attach themselves to the boiler plates, and, being decomposed, leave a greasy spot on the plates. This grease prevents the water from coming in contact with the plate, which probably gets more strongly heated; however, the plates rapidly corrode at these spots, but how far the action is chemical or mechanical, or combined, it is not so easy to decide.

Petroleum or other non-saponifiable lubricators should be used in every case where it is intended to utilise waste steam, direct, in heating the feed water.

I brought this corrosion of boiler plates under the notice of the late Mr. Keats, Chemist to the Metropolitan Board of Works, who said that this corrosion was due to sulphate of lime. If sulphate of lime be present in this scum, the corrosion may be more easily explained, as the generation of sulphurous acid is by no means improbable.

Chloride of magnesium, if present in large quantity in a feed water, will generate HCl, and which, escaping with the steam, will rapidly corrode the iron pipes conveying the steam. A water residuum heated to 260° F., evolves large quantities of HCl, if much chloride of magnesium be present. Probably the reason why this corrosion is not perceptible with marine boilers is because the steam pipes are made of copper.

The Decomposition of the Haloid Salts of Silver under the Influence of Light.—F. Griveaux.—The decomposition of the haloid silver salts occasioned by light may be considered as a dissociation similar to that produced by heat.—*Comptes Rendus*, Vol. cvii, No. 21.

NOTE ON ERYTHROXYLON COCA GROWN IN INDIA.

By C. J. H. WARDEN, M.D., F.R.C.S.

(Concluded from p. 262.)

The next point I propose referring to in conection with this enquiry is the apparent influence of cultivation and locality on the yield of alkaloid. For convenience of reference I have tabulated all the available information on the subject of cultivation in Table No. VI.

In Table No. VII. I have arranged the data regarding height above sea level, and average rainfall of the districts in which the samples were grown.

The various samples of coca leaf examined during the course of my experiments were thus grown under different methods of cultivation and climatic influences, and it will be of interest now to compare these conditions with those under which the plant grows in Bolivia, a district which is stated to produce the best leaves. Two articles have appeared by Drs. Squibb and Rusby respectively (*Pharm. Journ.*, 1885), which deal with the cultivation of the coca plant. Rusby for more than two months was continuously engaged in the study of the coca plant and its products in the districts of Bolivia. The district of Caroica may be considered fitly representing the remainder of Youngos, and Youngos as representing the principal coca districts of the republic. The first coca plantations are found at an altitude of 6400 feet, and after passing the 2000 feet level there are few, if any; and within this four to five thousand feet lie the cocales of Bolivia. The soil is very diversified, ranging from a very light decomposed shale or sandstone to a heavy blue or chiefly yellow clay. The rainy season begins in October and continues until May or June, during which period the rains are copious and almost constant. During the succeeding two months there is scarcely a drop of rain, and during the next two there are only occasional showers. By the natives the leaves are classed as sweet and bitter leaves. The sweet leaves contain an abundance of alkaloids other than cocaine; but usually contain a large percentage also of cocaine. In the sweet leaves the bitter taste of the cocaine is marked by the presence of the other alkaloids, while in the bitter leaves the taste of cocaine is predominant. It would appear that the percentage of sweet alkaloids varies inversely as the amount and continuousness of moisture the plant receives. From a high altitude, the best results as to total alkaloids have been yielded by plants grown on a hill side soil rich in vegetable manure. But a rivalry exists between this variety of soil and a yellow clay; the author is inclined to think that those who prefer the latter soil do so because it yields a somewhat larger crop.

The ground for the nursery beds is prepared during the latter part of the dry season by breaking it up very thoroughly to the depth of a foot or more. The plan of sowing the seeds broadcast as soon as gathered, and covering with a little earth, or better, a layer of banana leaves or decaying vegetable matter, has been found to answer: germination requires from eight to twelve days longer than by adopting the native method, which consists in depositing the seeds as soon as gathered in a shaded place in layers an inch or more deep, and covered with a thin layer of decaying leaves. The heat generated by the decomposition of the fleshy pericarps seems to induce germination, and the embryo bursts ity bony covering. This growth unites them in from eight to fourteen days into a solid mass, which is broken up into small pieces and planted in furrows in the nursery. In this process very many of the sprouts are broken off and the plants destroyed. A covering of brush or straw must be placed over the nursery, at first only 3 or 4 inches above the surface, and elevated as the plants grow.

On the manner in which the ground is prepared for the plantation much of the future well-being of the plant depends. The ground should be thoroughly powdered to

Table No. VI.

Source of leaves.	Per cent of alkaloid on anhydrous leaves.	Method of cultivation.
Central Terai Tea Co., Darjeeling ..	1·115	Seedlings received from Society in 1885; grown in Bungalow compound and receiving a slight forking by coolies. Soil, black loam; no manure used.
Matelli Tea Garden, Jalpaiguri ..	1·022	Seedlings from Society; about 18 months old. Virgin forest land, black on top, sandy underneath. Plants not specially treated.
Arcuttipore Tea Co., Cachar	1·369 1·671	Seedlings from Society; age about 19 months. Soil, sandy loam; vacancies in an old tea clearance; manured with old cow-dung and top dressed with soot.
Chulsa, Jalpaiguri Dooars	0·610	Seedlings from Society, 1887; planted out 4 feet × 4 feet in virgin forest; chocolate-coloured leaf-mould.
Jaunpore District	0·571	Seedlings from Society; about 2 years. Old sandy loam garden soil, highly manured.
Ranchi	1·069 0·811	Seeds from Paris; plants two years old. Planted 2′ × 2′. Soil, loam with much iron in it, of a chocolate colour; once manured with cow-dung.
Society's Gardens, Alipore, Calcutta	0·358 0·973	Seedlings of various ages, from 6 months to 2 years; some in pots and some planted in ordinary garden soil.

Table No. VII.

Districts.	Per cent of alkaloid on anhydrous leaves.	Height above sea level. Feet.	Average rainfall. Inches.
Central Terai Tea Co., Darjeeling..	1·115	About 900.	—
Matelli Tea Co., Jalpaiguri	1·022	About 1700.	About 180.
Arcuttipore Tea Co., Cachar ..	1·369 1·671	About 120.	Av. of six years, 129.
Chulsa, Jalpaiguri Dooars	0·610	2200.	180 to 200.
Jaunpore Districts	0·571	300.	30 to 40.
Ranchi	{1·069 0·811}	2200.	About 65.
Society's Gardens, Calcutta	{0·358 0·973}	—	About 66.

the depth of two or, if possible, three feet, and all roots and large stones removed. It is generally believed that shade tends to the production of the best quality of leaves, and the cocales are therefore planted thickly with a small broad topped leguminous tree related to the St. John's head plant. The custom appears to have arisen from two considerations. There is a period already referred to of two or three months during which no rain falls, and then these trees afford protection from the sun. Secondly, because shade conduces to the production of a large smooth leaf of elegant colour, and thus adds to the appearance of the product. From repeated comparative assays made by Rusby, of shade and sun grown leaves from adjoining plants, the sun grown leaves were invariably much richer in total alkaloids.

The plants are transplanted from the nursery at the advent of the permanent rains, and are set out from half an inch to three feet apart. They grow to a height of 2 to 6 feet, but the largest plants do not yield the best leaves. Great care must be taken to keep the soil thoroughly stirred and free from weeds. The first picking of leaves is made one year and a half from the date of transplanting, or two and a half from the date of sowing the seeds.

The chief danger of picking the leaves earlier than the period mentioned, is not the strain upon the vitality of the young plants, but because it is almost impossible to avoid breaking off the very tender tips of the twigs, the result being fatal to many plants.

During the first few years the percentage of alkaloids increases rapidly, reaching its maximum at or before the tenth year; at the age of twenty it begins to diminish, but with extreme slowness, so that plants are practically in their prime up to the age of thirty-five or forty. The decline is then probably due rather to exhaustion of the soil than of vitality of the plant. Fertilisation of the soil has never been tried, but it appears probable that as much could be done for the coca in this way as has been done for other plants.

The time of picking is determined solely by the condition of the leaves. When mature they turn yellow if in the dry season, and brown if in the rainy, and within eight days at the outside will fall if not plucked. No irrigation is resorted to during the dry season. Rusby is of opinion that though it is possible that irrigation might increase the size of the crop, yet, that after a long time, an abundant and steady supply of water would result in a decrease in the amount of alkaloids. Moist seasons produce the most delicate leaves of finest quality, while droughts are very destructive to the crops. Each bush, as a rule, yields three crops a year; or in exceptional localities, four crops.

After plucking, the leaves are exposed to a hot sun upon a pavement of well-fitted flat stones, and stirred occasionally until dry. Under favourable conditions the drying is accomplished in about three hours. A few drops of rain are sufficient to decolourise and ruin the sale of the coca, though Rusby thinks it probable that such decolourisation, if produced by little rain, does not necessarily indicate loss of alkaloid. After drying, the leaves are placed in storage sheds, when the leaf undergoes a slight sweating process.

As far as one can judge from the data available, altitude in India does not appear to have much, if any, effect on the percentage of alkaloid present in the coca leaf. Taking two extreme cases, the coca grown on the Matelli Tea Co.'s garden, Jalpaiguri, at an elevation of 1700 feet, yielded 1·022 per cent of alkaloids, while that grown at Arcuttipore in Cachar, at an elevation of only 120 feet, yielded from 1·3 to 1·6 per cent of alkaloid. Again, the amount of rainfall does not appear to have been a factor of any moment, for we have the coca grown in the Jaunpore District, with a rainfall of 30 to 40 inches, yielding only four-hundredths per cent less alkaloid than that yielded by the leaf grown at Chulsa in the Dooars, with a rainfall of from 180 to 200 inches. As Rusby points out, the plants must not only have an abundant supply of water at the roots, they must be bathed in a humid atmosphere for the greater portion of the year. In considering these questions, however, of altitude and climatic influences on the alkaloid contents of the leaf, it must be remembered that in order to make the results strictly comparable, the age of the plants and the condition of the leaf as regards maturity at the time it was plucked, should be similar in all cases. But the samples examined by me were picked at different periods; thus the Matelli,

and Central Terai Tea Co.'s leaf was plucked in July, the Chulsa and Jalpaiguri in October, the Arcuttipore twice a month since 18th May, 1887. Extreme caution is therefore requisite in drawing deductions as to the special adaptability of any particular district for the growth of coca. The necessity for this caution is well seen in the results of the examination of the samples grown in the Society's Gardens, Alipore. The first sample yielded only 0·358 per cent of total alkaloid, while the second, examined about six weeks later, contained 0·973 per cent of alkaloid, a difference of nearly 300 per cent.

As regards the effects of cultivation and manure on the yield of alkaloid, it would appear from the reports I have received that in only two of the districts was the soil specially manured. At Arcuttipore the manure consisted of old cow-dung, with a top dressing of soot. In the Jaunpore district the soil is stated to have been highly manured, but no particulars as to the precise nature of the fertiliser are afforded. The leaf grown at Arcuttipore yielded very considerably more alkaloid than any of the other samples examined; while that grown in the Jaunpore district contained only 0·571 per cent of alkaloid. I have no information whether the Arcuttipore plants were grown in the shade or open. On the Jaunpore Tea Estate there appear to be four plants, two in full sunshine, and measuring 5½ feet and 5 feet 2 inches in height respectively; one in partial shade 3 feet high, and one in shade 5 feet high; and I gather from the Manager's letter that the leaf sent me was collected from the plant which grew in the shade.

Taking into consideration the amount of potash contained in the leaves, and the rapid exhaustion of the soil which would necessarily ensue from repeated plucking of the leaves, it appears to me that, though at first a nitrogenous fertiliser would be beneficial, yet after a time the addition of a fertiliser containing potash in some form, in addition to the nitrogenous matter, would be necessary. The amount of nitrogen in the soot and cow-dung might possibly suffice, but whether the amount of potash in the cow-dung would be sufficient to supply the place of that removed from the soil by the leaves is an open question.

The method of drying the leaves by artificial heat instead of in the direct rays of the sun, does not appear to me objectionable. The object, which should, I think, be kept prominently in view, is to dry the leaves as thoroughly and quickly as possible at the lowest temperature. The plan adopted at Arcuttipore of first withering the leaves in the shade and then drying them in a tea dryer at 150° F. for ten minutes, appears to me as good as any. I do not think any advantage is to be gained by employing a higher temperature. In whatever way dried the leaves should be at once packed in air-tight boxes *directly they are cold.* Dried leaves exposed to air rapidly absorb moisture, and a few hours' exposure in a damp day will indicate in the leaf 18 to 20 per cent of moisture.

The amount of leaf yielded by a plant obviously varies with its age. At Arcuttipore, with plants about 19 months old, the Manager writing in August, 1887, states, that the leaf has been collected twice a month since 18th May last: the quantity of green leaf obtained at each plucking from nine plants varied from ¾ to 1 lb.; one pound of green leaf yielding about 3½ ounces of finished coca. At Chulsa, Jalpaiguri, 143 plants yielded 3 lbs. of dry leaf.

The apparent peculiarity of the alkaloid extracted from Indian grown coca leaves of not forming spontaneously crystallisable salts on evaporation of aqueous and other solutions, raises the question of the value of the drug for therapeutic purposes. In the manufacture of hydrochlorate of cocaine, the solution of the alkaloid in hydrochloric acid is evaporated at a low temperature with constant stirring, until the solid salt ceases to lose weight. Solutions of hydrochlorate of cocaine prepared from Indian grown coca leaves treated in a similar way, also yields a solid hydrochlorate. The physiological action of the hydrochlorate so prepared in numbing the tongue was very marked, but it seemed to me that it would be more satisfactory to have the opinion of a medical man on the suitableness of the drug for therapeutic purposes. Hydrochlorate of cocaine in a four per cent aqueous solution is employed in ophthalmic practice. I accordingly prepared a solution of that strength, which I submitted to Dr. Saunders, Professor of Ophthalmic Surgery at the Medical College, Calcutta, for report. Dr. Saunders has tried the effects of the drug on patients, and has very kindly favoured me with the following note of its action.

"I have used the solution of cocaine sent by you in some 13 operations for cataract, and many minor operations upon the eye: I find no difference in its physiological effect from other cocaine, except that it appears to have a quicker and a slightly stronger action. As an anæsthetic upon the eye it is perfect."

There can thus be no question regarding the activity of the alkaloid obtained from Indian coca. On purely pharmaceutical grounds the use of cocaine obtained from Indian coca might be objected to, as it does not apparently form spontaneously crystallisable salts, but as the salts of cocaine are, as a rule, used in solution, this objection cannot carry much weight. The percentage of alkaloid contained in samples of the Indian grown drug exceeds considerably the amount stated to have been found in any of the published assays of coca leaf which I have had an opportunity of seeing; and I think it not unlikely, that as the Indian plants—now in their infancy—mature, still larger percentages of alkaloid will be found in the leaves.

Thus, though the suitableness of India for growing coca is clearly established, the point whether it will be commercially successful or not to grow the drug there is another question. The present sources of coca are very large: according to Squibb (*Ephemeris*, May, 1887), the Peruvian Government is said to record and tax a production of over 15,000,000 pounds per annum, and the Bolivian Government about 7,500,000 pounds; of this latter quantity about 55 per cent is consumed in Bolivia, Argentine Republic and Chili each 14 per cent, and Peru 10 per cent, while the remaining 5 per cent is exported to the United States and Europe, thus giving about 375,000 pound as the export of Bolivia. As Peru produces about double the quantity credited to Bolivia it seems probable that about double the quantity may be exported, or 750,000 pounds, and if this, too, goes to the United States and Europe it would make an aggregate of about 1,125,000 pounds annually. Squibb pertinently remarks that 1,000,000 pounds of coca leaf would yield at least 2500 pounds of cocaine, while one-fourth of that quantity would probably overstock the whole world. Probably small parcels of Indian coca leaf would find a ready sale in Europe at good prices, but to plant out large areas would, I think, be a hazardous experiment. For it must be remembered that the uses of coca are very limited in Europe, the drug being almost solely used as a medicine, and, as far as one can judge, there is little or no chance of coca preparations ever coming into general use, for example, as beverages. The question of the synthesis of cocaine, enabling the drug to be prepared artificially on a large scale, is also a not very remote contingency, for work has already been done in that direction by Merck and others.

(In the "Report on the Botanical Gardens, Nilgiris, for 1884-5," the Superintendent remarks:—"Last winter this alkaloid is said to have fetched 2s. 6d. per grain. At this price, could it have been maintained, its cultivation would have been productive of enormous profits, but the price has since declined to 7d. per grain, and it is very unlikely that even this sum will be realised much longer. In this opinion Mr. Thiselton Dyer concurs, and he moreover wrote a short time ago to caution me against being too sanguine that the cultivation of coca would be a commercial success, or advising me at any rate to discount very largely the reports which had been spread abroad about it.")

In conclusion, it only remains for me to express my thanks to Mr. Blechynden, Secretary to the Society, for

the trouble he has taken not only in collecting samples of coca from the various districts, but in supplying me with information relative to local methods of cultivation.

EXPERIMENTS UPON ALUM BAKING-POWDERS, AND THE EFFECTS UPON DIGESTION OF THE RESIDUES LEFT THEREFROM IN BREAD.

By Prof. J. W. MALLET, University of Virginia.

It has been almost universally conceded that alum itself, when added singly to bread or other food, is positively injurious to health, and that its use, even in the small proportion sometimes employed to improve the appearance of bread made from unsound or inferior flour, must be regarded as reprehensible. But since the extensive introduction, in the United States, of baking-powders made with alum and bicarbonate of soda, there has been much dispute as to the harmlessness or harmfulness of the substances which are left in bread made with such powders after the mutual reaction of their constituents and the completion of the baking process.

It has been claimed by those who advocate the use of cheap baking-powders made with alum as one of the ingredients, that as soon as the mixture of alum (usually first deprived by heating of the whole or much the greater part of its water of crystallisation—so-called "burnt alum") and bicarbonate of soda is moistened, as in working it up with flour and water to form dough or "sponge," the aluminum sulphate is decomposed, sodium sulphate being formed, with which there also remains sulphate of ammonium or potassium, as ammonia or potash alum has been used, and the aluminum assumes the form of aluminum hydroxide, insoluble in water, and therefore supposed to be inert and harmless in the stomach and alimentary canal. It has been noticed that the aluminum is also partly converted into phosphate in presence of the phosphates naturally occurring in flour, and this has been also taken to be insoluble and inert. It has been further claimed that at the temperature of the baking oven aluminum hydroxide is itself decomposed, water being given off, and the highly insoluble aluminum oxide, or alumina, left behind, to be discharged from the intestines as might be so much clay or other harmless and indifferent matter.

On the other hand, it has been asserted, by some of those who oppose the use of alum in baking-powders, that the decomposition is not, or may not be, complete, and in any case that, as all of the constituents of the alum remain in the bread, the action upon the human system must be essentially the same as if the alum itself remained intact.

In the discussion of the effects on health of the residual substances left in bread made with alum baking-powders, there has been a good deal of loose argument, based upon data which were either merely assumed as probable or were too imperfectly supported by actual experiment. In such experiments as have been hitherto recorded, bearing directly on the question, there are many points left in an indeterminate state, and calling for further investigation in order to clear them up and admit of an impartial conclusion being reached. The following work was undertaken with a view to furnish some more exact and satisfactory evidence of the kind required for the purpose of reaching such a conclusion.

1. *General Nature of the Baking-powders Examined.*

Of these there were 27 samples, representing 17 different brands. It was thought desirable to examine, at least in some cases, several samples of the same brand, in order to form an idea of the degree of uniformity to be counted upon as presented by the product of the same manufacturer.

The samples were in unbroken original packages, as found in ordinary retail trade. A good deal of difficulty was experienced at first in procuring samples of some of the brands, until it was observed that not in the larger and better shops of the principal cities, but in smaller shops and more obscure streets and towns, were these to be met with, indicating sale chiefly among the poorer classes.

Nearly all of these powders contained as their acid ingredient a mixture of alum and acid phosphate of calcium ("superphosphate"). In but one case was alum alone found. The alum employed was, for the most part, made with ammonium, not potassium sulphate, although the latter salt was also met with either singly or mixed with the former.

All contained as the alkaline ingredient acid carbonate of sodium ("bicarbonate of soda"). All contained starch, or, in two or three instances, crude flour or starch imperfectly separated from gluten.

2. *Amount of Carbon Dioxide (Carbonic Acid) Gas given off on Moistening each Baking-powder with Water.*

As the object of using a baking-powder in making bread is to produce porosity, by the liberation and expansion of gas-bubbles uniformly distributed through the mass, the amount of gas set free from a given quantity of the powder by moistening it is obviously an important point to be determined.

This amount was found to be very variable on testing carefully under similar conditions the different samples examined. Reducing the volume of gas to the same standard temperature and pressure, and allowing for gas retained in solution by water at the temperature of each experiment, the smallest quantity obtained was 36·91 cubic inches from one avoirdupois ounce of baking-powder. The average for all the samples was 66·00 cubic inches from the same weight of powder. The largest quantity obtained was 99·37 cubic inches. Hence, if the average result be taken as the standard of comparison, a departure from it of as much as 44 per cent in defect and 50 per cent in excess was observed.

In obtaining these results no account was taken of any ammonium carbonate, which is employed, when at all, only in quite small proportion; this would only assume the gaseous form under the influence of the heat in baking.

The variability observed appears to be partly due to variation in the proportion of starch or other indifferent matter used, partly to the variable character of the commercial bicarbonate of soda employed (containing a larger or smaller proportion of true bicarbonate), partly to greater or less purity of the other active ingredients, partly to greater or less care in the adjustment to each other in proper proportions of the acid ingredients and the soda, partly to want of due care to insure uniform mixture of the ingredients, but mainly to greater or less absorption of moisture from the air in keeping, different degrees of care in drying the materials, and in putting up the powder in packages for sale, and no doubt difference in age of some of the samples.

3. *Relation of the Variable Product of Carbon Dioxide Gas to the Amount of Powder necessary to be used in making Bread.*

Aside from the bearing on the fitness for producing porosity in bread, and hence on the money value of a baking-powder, of the amount of carbonic acid gas given off by a given quantity of the powder, there is to be considered the bearing upon health of the habitual use of more or less of the powder to produce the same effect in "raising" bread. The directions accompanying most of the brands call for two teaspoonfuls, or in some cases two or three teaspoonfuls, for each quart of flour; but it may be safely assumed that in actual practice the bread-maker will take such a quantity as experience may show to be necessary to produce the desired "lightness," whether by varying the number of spoonfuls recommended,

or by changing the extent of filling of the spoon, or by discarding this measure in favour of some other the use of which is guided by observation of the resulting bread. Hence the use of a poor baking-powder, or one in poor condition, yielding but a small proportion of gas, will lead to the employment of a relatively larger quantity, and will cause a larger amount of residual matter to be left in the same quantity of bread, causing increased ill-effect upon health if such residual matter be injurious at all.

This point is to be borne in mind in forming any estimate of the quantity of residue from a baking-powder which any single consumer of bread made with it may have to encounter.

4. *Nature of the Ingredients in a Solution obtained by Treating the Several Baking-powders with Water, so far as Excess of Acid or Alkali derived from the Powder is Concerned.*

On acting with a definite excess of cold water upon each sample examined, and filtering off the solution after escape of gas has ceased, leaving on the filter the starch and insoluble mineral products of the chemical action which had taken place, the clear liquid was examined as to its reaction to test-paper, and the excess of acid or alkali was carefully determined.

In nearly all cases the liquid was alkaline, and the excess of alkali present was found equivalent to an amount of bicarbonate of soda varying from 2·06 to 19·11 grains for each ounce avoirdupois of baking-powder used.

In two cases the reaction was acid, and to an extent which, if the excess be counted as alum over and above that required to neutralise the soda present, would be equivalent in the one case to 0·86 grain, and in the other case to 3·14 grains of *burnt* ammonia alum (or to 1·58 grains and 5·78 grains of *crystallised* ammonia alum respectively) per ounce of baking-powder. In fact, these two baking-powders, being made with alum and acid calcium phosphate, the acidity was in part due to excess of the latter salt, though a soluble compound of aluminum was also present.

These results indicate the degree of variation in the adjustment to one another of the acid ingredients and the bicarbonate of soda, more or less carelessness as to the purity, and therefore real chemical efficiency of the two classes of material, especially, in all probability, as to the relative proportions of true bicarbonate of soda, of the neutral carbonate, and of moisture in the soda used, and more or less inaccuracy in the weighing out, and want of uniformity in the mixing of the materials as taken.

5. *Examination of the Watery Solution from the Several Baking-powders as to the Presence therein of Aluminum and Calcium.*

It has been commonly claimed, in defence of baking-powders made with alum, that, conceding this salt to be itself injurious, it is decomposed in acting upon the bicarbonate of soda, assuming the alkaline material to be used in sufficient amount, hydroxide (or hydrate) of aluminium being formed, and that the latter is quite insoluble, and hence inert physiologically, so that no harm can result from its presence in the digestive organs. It has usually also been assumed that the calcium of calcium acid phosphate is rendered insoluble by conversion into tribasic phosphate on reaction with a sufficient amount of bicarbonate of soda.

On examining, however, the solutions obtained by acting with water on the various baking-powders examined, due care being taken to remove any silica, to decompose any phosphate present, and to fully identify the aluminum and calcium found, it appeared that these solutions in all cases (except a single brand, made with alum alone without phosphate, in which there was but a trace of calcium) contained both aluminum and calcium, in relatively small quantity it is true, but in some cases to an extent equivalent to as much as 4·19 grains of burnt or 7·72 grains of crystallised ammonia alum, and to as much as 3·15 grains of lime per ounce of baking-powder. Hence it is not true that the aluminum and calcium are left in a condition wholly insoluble in water; at any rate, in the presence of the other residual material of the baking-powder.

In the powders containing calcium acid phosphate along with alum, part of the lime is in solution as carbonate dissolved by excess of carbonic acid. In such of these phosphate and alum powders as had least excess of alkali (bicarbonate of soda), the whole, or nearly the whole, of the phosphoric acid was left in the part of the residue insoluble in water.

6. *Presence of a little Organic Matter (Soluble Starch) in the Watery Solution obtained from the Baking-powders.*

The solution obtained by acting on the powders with excess of cold water gave a strongly-marked violet tint with a weak solution of free iodine, due to the presence of a little soluble starch. No dextrine or glucose was found. The presence of organic matter, although in very small amount, may possibly aid in bringing a little aluminum, or calcium phosphate, or aluminum hydroxide, into solution.

7. *Existence of Aluminum largely as Phosphate in Consequence of the Use of Calcium Acid Phosphate along with Alum.*

It has been pretty generally assumed that from alum baking-powders the aluminum is left mainly as hydroxide (hydrate) in the bread, though attention has been drawn to the fact that some aluminum phosphate may be expected to be formed from the phosphates of the flour itself. The quantity of aluminum phosphate so produced would probably be small. But, so far as the samples now reported on may be taken to represent the usual character of the alum baking-powders at present in the market, it will have been seen that nearly all of them are made with both alum and calcium acid phosphate, and in the reaction of these two ingredients on each other we have a source of the much more abundant production of aluminum phosphate. In fact, in all the powders of this mixed character examined, nearly the whole of the aluminum was present as phosphate after treatment of the powder with water. Not quite the whole, however, as in two or three cases aluminum was detectable in the watery solution, while the phosphoric acid was left altogether in the insoluble residue. Of course, in such baking-powders as are made with alum alone (no phosphate), the aluminum is left mainly as hydroxide.

8. *Presence of Iron in Small but Varying Amount in the Baking-powders Examined.*

Although the quantity of iron in any of the samples examined must have been quite small, and no special attention was given to its determination, it was incidentally observed that this impurity varied very notably from one sample to another. This seems to indicate very different degrees of pains taken by different manufacturers to procure and use pure materials.

9. *Determination of the Temperature to which the Interior of Bread is Subjected in the Process of Baking.*

As aluminum hydroxide and aluminum phosphate are heated they give off water, and in consequence of this loss of water they become less soluble in acids, the anhydrous aluminum oxide (or alumina) being practically altogether insoluble in diluted or even pretty strong acids, while the anhydrous phosphate can be dissolved by them only slowly and with difficulty. When, therefore, we come to consider the solubility or insolubility of the residues left in bread from alum baking-powders, not in water, but in the digestive fluids, especially in the acid gastric juice, it is important to know in what condition of hydration these residues are left in the bread, *i.e.*, how far water has already been driven off and insolubility produced, and as a first step we need to know to what temperature the in-

terior of the bread has been exposed in the oven during baking.

There is ample information to be found as to the usual or desirable temperature of *the oven*, but I have found no results of direct experiments on the temperature attained by the interior portions of the bread itself. It is remarked by some writers that, as there is much water still left in the bread when the baking is complete, the temperature of the inside of a loaf cannot be expected to much, if at all, exceed the boiling-point of water under common atmospheric pressure. But it seemed desirable to make some direct observations on this point, and this has now been done; the temperature of the oven, and of the interior of the bread while baking, and up to the time of withdrawal, having been noted—1st, For a large public baking-oven of brick, 12 feet by 14 feet, heated by a coke fire; 2nd, For a smaller brick oven in family use; and 3rd, For the ovens of ordinary cast-iron cooking stoves burning wood and coal respectively. The results were substantially uniform. The temperature of the oven atmosphere varied from 472° to 496° F., while the maximum temperature shown by a registering thermometer with its bulb in the centre of a larger or smaller loaf of bread, ranged from 197° to 212° F., never exceeding the latter point. In the case of the lowest temperature noted the bread as taken out of the oven was not quite sufficiently baked through, retaining rather more than a proper amount of moisture in the centre of the loaf. Hence it may fairly be concluded, as the result of direct experiment, that the aluminum hydroxide and hydrated aluminum phosphate left in bread from alum baking-powders are never exposed in baking to a temperature higher than 212° F.

10. *Determination of the Condition of Hydration of Aluminum Hydroxide and Hydrated Aluminum Phosphate after Drying at 212° F.*

These two substances were prepared in a pure state by precipitation, carefully washed, and allowed, in the first instance, to become dry at the common temperature of the atmosphere, covering them lightly to exclude dust. A portion of each, contained in a small "boat," was then exposed in a wide tube, maintained at or close to 212° F. by an outside bath of water kept boiling, to a slow current of air nearly saturated with moisture at the same temperature, so as to place the material experimented on as nearly as possible in the same condition as if it were enclosed in a mass of bread undergoing the process of baking. This state of things was maintained for an hour and a half—a time considerably longer than that usually occupied in baking. The boat was withdrawn from the tube and accurately weighed, then heated gradually to bright redness, cooled, and weighed a second time. The difference between the results of the two weighings gave the amount of water removable from the material taken as in the condition in which it would exist in baked bread. The results were as follows:—

Aluminum hydroxide,	as taken,	gave off	39·11% water.
„ phosphate,	„	„	31·65 „

These figures correspond to about one molecule of surplus water for each three or four molecules of the normal aluminum hydroxide ($Al(HO)_3$), and a little over three molecules of water for each molecule of normal aluminum phosphate ($AlPO_4$).

11. *Experiments upon the Influence on Digestion of Moderate Doses of Aluminum Hydroxide and Aluminum Phosphate Swallowed shortly before or along with Food.*

Having been interested by the results of a few experiments made in my own person a year or two ago on the apparent interference with digestion of these substances, I have tried a larger number of such experiments under more carefully noted conditions and with definite quantities of the materials used, in order to test directly the physiological effect of the residues from alum baking-powders, so far as this can be determined by their action in the case of a single person.

The experiments were made with a carefully prepared stock of the pure hydroxide and phosphate of aluminum, dried at 212° F., in the way and to the extent described above (10). A weighed quantity of one or the other was swallowed, either before—generally about ten minutes or a quarter of an hour before—a regular meal (using only a little water with the powder) or along with the food of an ordinary meal, and the effect, if any, upon the course of digestion noted and recorded. The experiments were made with intervals of three or four days between them; the food taken was of various kinds, but always simple and wholesome, and not likely of itself to produce disturbance of digestion; there was no pre-existing derangement of the digestive functions when any experiment was undertaken; as much care as possible was taken to avoid any mere fancying of expected symptoms, and to state with moderation what was actually experienced. The results of all the experiments made were recorded, and the record was preserved in the words which seemed at the time most accurately to express the sensations observed.

While on two or three occasions, particularly with the smallest doses used, there was no clearly observable effect, the general tenor of the experiments seemed to establish beyond doubt on my part the fact that the ingestion of the aluminum compounds used produced an inhibitory effect on gastric digestion, while in some cases, particularly with the larger doses, and on the whole rather with the hydroxide than the phosphate for equal weights of the two, the interference with the course of digestion was very notable. There was no gastric pain, nor were there any other symptoms of gastric or intestinal irritation, but simply the well-known oppressive sensations of indigestion properly so called, lasting for a longer or shorter time, but generally for at least two or three hours after the taking of food.

The quantity of aluminum hydroxide swallowed in each experiment varied from 10 to 50 grains, the average for all the experiments being about 28 grains. The quantity of aluminum phosphate used ranged from 10 to 100 grains, the average being 45 grains. These doses were intentionally made larger than the quantities of the aluminum compounds in question derivable from such an amount of bread as would usually be eaten at a time if alum baking-powder in anything like usual proportion had been employed in making it. The object was to ascertain with what doses distinct effects were noticeable, and this seemed to be generally the case with any dose not less than 20 grains of the hydroxide or with not less than 30 or 40 grains of the phosphate. It may, of course, be reasonably supposed that a considerably less quantity than would be necessary to produce decided discomfort when once administered might prove objectionable and injurious if habitually taken as a part of the bread of each daily meal. With the proportion of alum in most of the baking-powders in use, with the allowance of two teaspoonfuls (counted as about 200 grains, though as much as 250 grains was found to be sometimes measured by a cook) of powder to a quart of flour, and assuming 35 or 40 per cent of water in baked bread, a pound of bread would contain about 13 or 14 grains of aluminum hydroxide if alum alone were used in making the powder, or about 20 or 21 grains of aluminum phosphate if alum and calcium acid phosphate were used together, and all the aluminum were left in the bread as phosphate—these weights being taken for the substances assumed in the condition of hydration shown by the experiments recorded in preceding paragraphs.

(To be continued).

PROCEEDINGS OF SOCIETIES.

THE ROYAL SOCIETY.

THE Anniversary Meeting of this Society was held on Friday, November 30th, at Burlington House. The President (Professor Stokes) having delivered the anniversary address, the medals were presented as follows:—The Copley Medal to Professor Thomas Henry Huxley for his investigations on the morphology and histology of vertebrate and invertebrate animals; the Davy Medal to Mr. William Crookes, for his investigations on the behaviour of substances under the influence of the electric discharge in a high vacuum; the Rumford Medal to Professor Pietro Tacchini, for his investigations on the physics of the sun; a Royal Medal to Sir Ferdinand von Müller, for his investigations of the flora of Australia; and a Royal Medal to Professor Osborne Reynolds, for his investigations in mathematical and experimental physics. The Society next proceeded to elect the officers and Council for the ensuing year.

President—Prof. George Gabriel Stokes, M.A., D.C.L., LL.D.

Treasurer—John Evans, D.C.L., LL.D.

Secretaries—Prof. Michael Foster, M.A., M.D; the Lord Rayleigh, M.A., D.C.L.

Foreign Secretary—Prof. Alexander William Williamson, LL.D.

Other Members of the Council—Prof. Henry Edward Armstrong, Ph.D.; Henry Bowman Brady, F.G.S.; Charles Baron Clarke, M.A.; William Huggins, D.C.L.; John Whitaker Hulke, F.R.C.S.; Prof. John W. Judd, F.G.S.; Edward Emanuel Klein, M.D.; Prof. E. Ray Lankester, M.A.; Prof. Herbert McLeod, F.I.C.; Sir James Paget, Bart., D.C.L.; William Pole, Mus. Doc.; William Henry Preece, M.I.C.E.; Sir Henry E. Roscoe, D.C.L.; Edward John Routh, D.Sc.; Prof Arthur William Rücker, M.A.; and William James Lloyd Wharton, Capt. R.N.

In the evening the Fellows and their guests dined together at Willis's Rooms. In returning thanks for the health of "The Medallists," Mr. CROOKES said:—

In the absence of Professor Huxley, who unfortunately is unable to be present this evening, I have been asked by our President to return thanks for the Medallists.

The Professor, in whose shoes I now stand, has lately put it on record that for twenty years he never rose to make a speech without his tongue cleaving to the roof of his mouth through sheer nervousness. I, on whom his duties have fallen, but, alas! not his mantle, crave your indulgence if I show that nervousness for which I can quote so excellent an authority, and beg you to bear with me patiently in what must be as great a disappointment to you as it is to myself.

Although I feel it embarrassing to take the place of a philosopher so renowned as Huxley, I am bound to say that even he cannot receive the Copley Medal—the ancient olive crown of the Royal Society, as it was called by Sir Humphry Davy—without regarding it as the culminating honour of his scientific career. I am also bound to say that the award of this Medal to such a man as Huxley confers at least as much honour on the Royal Society as on its renowned Professor.

As regards the other recipients of the Medals, Professor Tacchini the Romford Medallist, Sir Ferdinand von Müller and Professor Osborne Reynolds the Royal Medallists,—co-workers with myself in very varied departments of science,—judging from my own feelings at the present moment, I cannot do better than express on their behalf the sincerest gratification at the high recognition you have bestowed on their scientific work.

For my own part, as the Davy Medallist, I may perhaps be permitted to speak at somewhat greater length. Thirteen years ago in this very room, at the Anniversary Dinner of the Royal Society, I had the honour to return thanks to this Society for conferring on me the distinction of a Royal Medal. The President, Dr. Hooker, in handing to me the Medal, referred to the then novel instrument the Radiometer, and in the course of his remarks he made the following observation:—

> "It is the mystery attending this phenomenon that gives it its great importance. There is evidently some action going on with which we are not at present acquainted; and there is no saying what a thorough investigation into the cause of the phenomenon may lead to."

From that date to the present I have not ceased to work at the elucidation of the mysteries accompanying high vacua. During this interval of thirteen years the theory of the Radiometer has been established on a firm basis. Since the advent of the Radiometer the Otheoscope has been devised and its action elucidated; lines of molecular pressure in high vacua have been illuminated so as to render visible to the bodily eye those actions which hitherto had been seen only by the eye of faith; molecular shadows have been projected; luminous streams have been deflected and magnetised; platinum has been melted by molecular impact; the existence of matter in a fourth state—"radiant matter"—has been demonstrated; and the strikingly brilliant phenomena of phosphorescence in high vacua have been discovered.

The results of these investigations I have embodied in ten memoirs and Bakerian Lectures which have appeared in the *Philosophical Transactions*, in eighteen papers which have been inserted in the *Proceedings of the Royal Society*, and in fifteen other papers published elsewhere.

In the spectroscopic examinations which these researches necessitated I constantly met with a bright citron-coloured line, sometimes strong, at others only a ghost of a line, but always in the same place, and presumably due to the same cause. The hunting out of this phantom line has been a work of many years. At last I found it to be due to yttria, while a corresponding red line was tracked to samaria.

Here a new field, indeed I may say a new world, of research unfolds itself to the chemist. The phosphorescent light from yttria gave in the spectroscope a complicated and beautiful series of coloured lines. But these lines varied in different specimens of the same earth from different localities, some being strong and others weak almost to extinction. Chemical tests showed that in each case the earth was free from known impurity, and for a long time the interpretation was inexplicable. I was confronted with a series of inscriptions from the molecular world, written in a strange and baffling tongue, and requiring a Rosetta stone to give the first step to decipherment. How the key of the mystery came into my hands, and what resulted therefrom, are now matters of history. The meaning of the lines, their positions and variations, is gradually becoming clearer and clearer, and to me this is what they seem to be saying:—

They tell me that in matter which responds to every test of an element, which possesses an atomic weight and combines with other matter in definite proportions, there still exist minute shades of difference among which a process of selection is possible.

They tell me that the time-honoured distinction between elements and compounds, as it exists in the Lavoisierian and Daltonian chemistry, must be modified to make room for a vast array of intermediate bodies, or as I have elsewhere called them Meta-Elements, capable of isolation and identification.

They tell me that there exist degrees of rank in the hierarchy of the chemical elements, some being, so to speak, more elemental than the others, some still waiting to be discovered, whilst others may have disappeared and are no longer existent under the conditions in which we are now placed.

They tell me, again, that our chemical elements are products of the action of forces on a state anterior to

matter, which I have designated as Protyl; that these elements owe their present stability in that they are the outcome of a struggle for existence, a Darwinian development by chemical evolution; that just as in the organic world we have the "survival of the fittest," so here we have the "survival of the most stable" or possibly of the "most inert."

There are other lessons as yet only indistinctly whispered, lessons which, possibly to-day, but certainly in days to come, will be seized on and interpreted.

But I will no longer weary you with speculations which have not yet received full and final confirmation. It only remains for me to thank you for the high distinction of the Davy Medal—a distinction all the more welcome as it has only once previously been awarded to one of our own countrymen. I deeply appreciate the kind reception you have given me and the very gratifying remarks with which the presentation has been accompanied.

Refreshed and stimulated by your friendly words of encouragement, I shall continue to apply myself to what Darwin called "the vivid pleasures of investigation." I shall attack with renewed energy the problems of Radiant Matter Spectroscopy, and do my utmost "to pluck out the heart of the mystery."

NOTICES OF BOOKS.

Force and Energy: A Theory of Dynamics. By Grant Allen. London: Longmans, Green, and Co.

Most of our readers will doubtless have become acquainted with Mr. Grant Allen as the author of not a few biological treatises, memoirs, and articles, which, if containing little that is novel in fact or profound in theory, have the great merit of presenting the truths of evolution in a form "understanded of the people." But to meet with him as the author of a novel physical speculation is certainly an unexpected event.

Passing over a somewhat lengthy "apology," which stands in place of a preface or introduction, and in which the author avows himself no physicist, we come at once to the gist of the author's views. We find a novel definition of "energy" and "force," both being included under "power," as the widest generalisation of dynamics. With Mr. Allen, power is "that which produces or destroys, increases or lessens, motion in any particle or particles of any substance whatsoever cognisable by man."

Force the author defines as "a power which initiates or accelerates *aggregative* motion, whilst it resists or retards *separative** motion in two or more particles of ponderable matter, and possibly also of the ethereal medium."

Energy, on the contrary, is a power which resists or retards *aggregative* motion, while it initiates or accelerates *separative* motion in two or more particles of ponderable matter, or of the ethereal medium."

Of force, the author tells us, there are four species, exerted respectively between masses, molecules, atoms, and "electrical units." These are gravitation, cohesion, chemical affinity, and electrical affinity. Energy is, in like manner, classified as molar, molecular, chemical, and electrical. The term "chemical energy," it is expressly pointed out, is used to signify not a combining but a decomposing agency. The "Persistence of Force" and the "Conservation of Energy" are included under a head entitled the "Indestructibility of Power."

The essential point, then, in the author's dynamical consideration is the general opposition proclaimed between all the forces or aggregating agencies on the one hand and the energies or segregating agencies on the other. Of course Mr. Grant Allen or any other writer may claim the liberty of attaching novel connotations to any accepted term, and so long as no confusion is produced, the claim must be granted. But the question is:—Do the author's speculations throw any new light on physical and chemical phenomena, or do they point the way for future research? "Theories," said Dumas, "are like crutches; to find their value we must take them and try to walk with them." Now we do not see clearly that Mr. Grant Allen's *aperçu*—the term is his own—will enable us to reach any vantage ground which we do not occupy already, or which we are not in process of reaching.

It may also be asked whether the complete antagonism between forces and energies—using the terms in the author's manner—which we here find is justifiable? Heat is here classified as a species of energy, as a power which resists aggregation. Yet the author admits that heat is necessary to make carbon combine with oxygen, and that light is required to effect the union of hydrogen and chlorine. Surely, then, heat and light may be regarded, according to circumstances, either as "forces" or "energies."

The picture of the gradual degradation of the universe and of the waste of its energies by transfer to the ether, "the great waste-heap of the universe," is given in great detail in the second part of the work. But we encounter here nothing but what is familiar.

* The italics are our own.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 21, November 19, 1888.

On the Collection of the Ancient Greek Alchemists.—M. Berthelot.—The publication both of the Greek text and of the translation is now completed, with the exception of the index and analytical tables. The fourth part contains works and extracts ascribed to various ancient authors, Pelagius, Ostanes, Johannes the Archpriest, Comarius, Justinianus, Jamblichus, and pseudo-Moses. The two last-mentioned writings seem to contain portions contemporary with the papyrus of Leyden. The sixth part contains the Byzantine commentators: Christianus, Philosophus anonymus, Cosmas Hierotheus, Nicephorus Blemmides. The fifth part is the most interesting. It contains technical treatises on working in gold, on tempering and colouring bronze and iron, on casting bronze, gilding iron, the manufacture of leaf gold, the colouration of artificial precious stones, the treatment of pearls, the preparation of a lye of wood-ashes, the manufacture of beer and soap. Most of these treatises seem to have been derived from a great Byzantine manual of applied chemistry, composed about the eighth or ninth century.

Benzidine Hydrochlorates: their Dissociation by Water.—P. Petit.—Benzidine forms a mono- and a dihydrochlorate. The former is stable in its solutions. The dihydrochlorate is decomposed by water according to two distinct laws. When the concentration does not reach 5·4 grms. per litre, a constant fraction, $\frac{1}{1000}$, is decomposed into monohydrochlorate and free hydrochloric acid. If the concentration exceeds 5·4 grms. per litre, crystalline monohydrochlorate is deposited, and the quantity of the dihydrochlorate dissolved is the sum of two terms, the one constant, which is the fraction corresponding to 5·4 grms., the other proportional to the excess of the weight above 5·4 grms.

Bulletin de la Société Chimique de Paris. Vol. l., Nos. 6 and 7.

Determination of Phosphoric Acid.—G. Linossier.—For separating and determining phosphoric acid on

author's principle, it may be precipitated as bismuth phosphate according to the indications of Chancel. To this end the solution of the phosphate, acidified with nitric acid, but free from hydrochloric and sulphuric acids, is raised in a porcelain capsule to a temperature close upon boiling, and mixed with an excess of bismuth nitrate. Bismuth phosphate is very rapidly deposited, and the supernatant liquid is quite clear. It is decanted upon a filter, and the precipitate is repeatedly washed with boiling water by decantation. When pouring the washings upon the filter it is important to let fall along with them only the smallest possible trace of the precipitate. Cease to wash when the liquid no longer shows an acid reaction. The filter is then placed over a clean flask, and there is poured upon it a saturated solution of sulphuretted hydrogen to decompose the traces of bismuth phosphate carried along with the washing water, and to set the phosphoric acid at liberty. The mass of the precipitate remaining in the capsule is treated in the same manner with sulphuretted hydrogen, and well agitated with a saturated solution of this gas. When the reaction seems complete the clear liquid is poured upon the filter and the residue treated with a fresh quantity of sulphuretted hydrogen. Finally, the bismuth sulphide is thrown upon the filter and washed with a solution of sulphuretted hydrogen, until a drop of the filtered liquid no longer reddens Poirrier's orange. The filtrate is freed from sulphuretted hydrogen by boiling, and the phosphoric acid is determined by titration with decinormal solution of soda, using orange 3 (Poirrier) as indicator. The exact point of neutralisation may be difficult to seize, as the change of colour is gradual in dilute solutions. It is, therefore, well to place, side by side of the flask containing the acid liquid, a similar flask, containing a volume of water equal to the volume of the phosphoric solution, coloured with the same quantity of orangé, and to continue the addition of soda until the colour in both flasks is exactly alike.

Determination of Chlorine.—G. Linossier and M. Lignon.—The author precipitates the solution of chloride cold, or slightly heated with a slight excess of mercurous nitrate. Mercurous chloride very quickly collects at the bottom of the capsule. The clear liquid is decanted upon a small filter, the precipitate is repeatedly washed by decantation in the capsule, pouring each time the washings upon the filtrate as free as possible from any trace of the precipitate. The remaining treatment is exactly analogous to that directed by the author for the determination of phosphoric acid.

New Method of Preparing Acetones.—M. l'Abbé J. Hamonet.—The author gives detailed directions for the preparation of propione or diethyl-carbonyl, of butyrone or dipropyl-carbonyl, and of œnanthylone or dihexyl-carbonyl.

MISCELLANEOUS.

Dinner to Dr. A. W. Williamson, F.R.S.—As our readers are aware, a subscription was set on foot soon after the retirement of Dr. Williamson from the Chair of Chemistry at University College, to secure some lasting memorial of his services to our science. Although the subscription was limited to a guinea, it has been so warmly responded to by his old students and colleagues, that it was possible to commission the Hon. John Collier to paint Dr. Williamson's portrait. On Wednesday next, December 12th, at 4.30 p.m., this portrait will be presented to University College by Sir Henry Roscoe on behalf of the subscribers. In the evening of the same day, at 7 p.m., Sir Henry Roscoe will take the chair at a dinner of the subscribers at the Freemasons' Tavern.

Royal Institution.—The following are the lecture arrangements before Easter:—Professor Dewar, six lectures (adapted to a Juvenile Auditory) on Clouds and Cloud-land; Professor G. J. Romanes, twelve lectures constituting the second part of a Course on Before and After Darwin (The Evidences of Organic Evolution and the Theory of Natural Selection); Professor J. W. Judd, four lectures on The Metamorphoses of Minerals; Dr. Sidney Martin, four lectures on the Poisonous Action of Albumenoid Bodies, including those formed in Digestion; Professor J. H. Middleton, four lectures on Houses and their Decoration from the Classical to the Mediæval Period; Professor Ernst Pauer, four lectures on The Characters of the Great Composers and the Characteristics of their Works (with Illustrations on the Pianoforte); and eight lectures by the Right Hon. Lord Rayleigh on Experimental Optics (Polarisation, the Wave Theory). The Friday Evening Meetings will begin on January 25th, when a Discourse will be given by Professor G. H. Darwin; succeeding Discourses will probably be given by Professor W. C. McIntosh, Sir William Thomson, Professor A. W. Rücker, Mr. Harold Crichton Browne, Professer Oliver Lodge, Professor Archibald Geikie, the Rev Alfred Ainger, the Right Hon. Lord Rayleigh, and other gentlemen.

MEETINGS FOR THE WEEK.

Monday, 10th.—Medical, 8.30.
— Society of Arts, 8. (Cantor Lectures). "Light and Colour," by Capt. W. de W. Abney, F.R.S.
Tuesday, 11th.—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
Wednesday, 5th.—Society of Arts, 8. "Explosives," by W. H. Deering.
— Microscopical, 8.
— Pharmaceutical, 8.
Thursday, 13th.—Royal, 4.30.
— Mathematical, 8.
— Institute of Electrical Engineers, 8.
Friday, 14th.—Astronomical, 8.
— Quekett Club.

TO CORRESPONDENTS.

A. B. E.—An examination has to be passed before becoming a Fellow of the Chemical Institute. No examination is necessary to become a Fellow of the Chemical Society. Apply to the respective Secretaries.

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J. E. WAKEFIELD,
Clerk of the Board.

Spring Gardens, S.W.,
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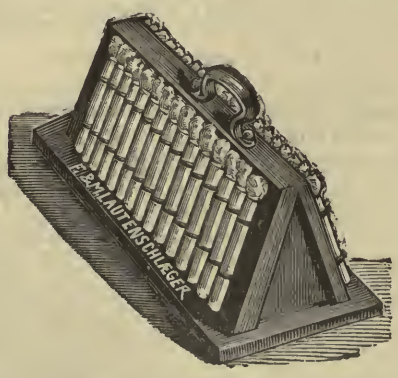

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1516.

REPORT OF RESEARCHES ON SILICON COMPOUNDS AND THEIR DERIVATIVES.*

Part I.

By J. EMERSON REYNOLDS, M.D., F.R.S.,
Professor of Chemistry, University of Dublin.

The present investigation was undertaken some years ago with a view to examine the action of the silicon haloids—but more especially of silicon tetrabromide—on various compounds containing nitrogen, as our knowledge of the relations of silicon and nitrogen is extremely limited.

It was ascertained at an early stage of the inquiry that the bromide of silicon is much superior to the chloride as a reagent with nitrogenised compounds, but since the bromide had apparently not been obtained in any quantity even by its discoverer, Serullas, considerable time had to be devoted to working out a method for the production of a sufficiently large supply of this material. The method adopted is described in the full paper.

In the purification of the crude tetrabromide a new *chlorobromide† of silicon* was discovered, which boils at 141° C. This proved to be the compound $SiClBr_3$, which was required to complete the series of possible chlorobromides of silicon.

The first group of nitrogen compounds subjected to the action of silicon tetrabromide included the primary thiocarbamide or sulphur urea, obtained by the author in 1869, and the allyl-, phenyl-, and diphenyl-thiocarbamides.

All these are shown to unite with silicon tetrabromide, and afford the highly condensed compounds—

$$(H_4N_2CS)_8SiBr_4,$$
$$(C_3H_5,H_3N_2CS)_8SiBr_4,$$
$$(C_6H_5,H_3N_2CS)_8SiBr_4,$$
$$((C_6H_5)_2H_3N_2CS)_8SiBr_4.$$

These are more or less vitreous solids, with the exception of the allylic compound, which is a transparent and singularly viscous liquid. All are dissolved and decomposed by water and by alcohol.

The action of alcohol on the compound $(H_4N_2CS)_8SiBr_4$, was studied in detail, and it is shown that not only do ethyl bromide, thiocyanate, and diethylic silicate result, but that the representatives of two new classes of thiocarbamide derivatives are formed.

The first of these is a beautiful *tetrathiocarbamide* compound, whose formula proved to be—

$$(H_5N_2CS)_4NBr,$$

which may obviously be written

$$(H_4N_2CS)_4H_4NBr.$$

This body separates from alcohol in fine masses of crystals resembling sea anemones in appearance, which melt at 173—174°, and begin to decompose at 178—180°. The synthesis of this substance was effected by heating ammonium bromide with thiocarbamide.

Several homologues of the above *tetrathiocarbamidammonium bromide* were produced by synthetic methods; some of these contain chlorine or iodine instead of bromine.

The following are examples of the compounds formed in the course of this part of the investigation:—

$$(H_4N_2CS)_4H_4NBr,$$
$$(H_4N_2CS)_4H_4NCl,$$
$$(H_4N_2CS)_4H_4NI,$$
$$(H_4N_2CS)_4(CH_3)H_3NBr,$$
$$(H_4N_2CS)_4(C_2H_5)_2H_2NBr,$$
$$(H_4N_2CS)_4(C_2H_5)_3HNCl.$$

By the action of silver nitrate on the tetrathiocarbamidammonium bromide the crystalline *dithiocarbamide* compound with silver bromide was obtained—

$$(H_4N_2CS)_2AgBr.$$

This was subsequently produced by the direct union of thiocarbamide with the pure silver haloid. The compound—

$$(H_4N_2CS)_2AgCl$$

was also obtained in fine crystals, as were other similar substances.

A *trithiocarbamide* compound is also formed during the action of ethyl alcohol on $(H_4N_2CS)_8SiBr_4$, but it is much more soluble than that which first separates. It is also crystalline, and its analysis and reactions lead to the formula—

$$(H_5N_2CS)_3Br,C_2H_5Br.$$

Hitherto only mono- and di-thiocarbamide derivatives have been known; but the results above stated in outline prove that tri- and tetra-thiocarbamide compounds are formed in presence of silicon tetrabromide and certain other agents, which latter form addition products with the condensed amide.

So far, cases were only dealt with in which silicon tetrabromide combined with nitrogenised groups without loss of its halogen. The next stage of the inquiry involved the investigation of certain interactions in which the tetrabromide loses *all* its halogen. One of the chief results obtained in that direction forms the subject of a separate communication.

* Read before the Royal Society, November 22, 1888.

† The chlorine required for the production of this compound was derived from the crude bromine (which always contains chloride of bromine) used in preparing the tetrabromide.

ON THE PREPARATION OF BORON.

By S. G. RAWSON, B.Sc.

The ordinary methods for the preparation of this element present a certain amount of difficulty when only a small quantity of it is required. Usually boric anhydride is fused with metallic sodium and the resulting mass exhausted with water. The decomposition is one which takes place with great violence, besides involving the use of special apparatus, such as an iron crucible, and the subsequent washing consumes much time. For these reasons, therefore, the following method seems to offer some advantages.

A mixture of 3·5 grms. B_2O_3 and 11·0 grms. CaF_2 is taken and treated in a flask with concentrated sulphuric acid. A continuous stream of boron fluoride can be readily obtained by gently warming the flask. The gas is then passed through a piece of hard glass tubing on which three or four bulbs have been blown and in each of which a little potassium has been placed. The bulbs are heated in turn, decomposition occurring with the formation of potassic fluoride and liberation of boron. The mass is then thrown on to a filter and can be readily and completely washed, leaving the boron behind. The experiment is also an interesting one to show on the lecture table from the easy and rapid manner in which the boron is set free.

Silicon fluoride treated in a similar manner also readily decomposes, depositing silicon as a brown amorphous powder, from which the fluoride of potassium can be removed by washing, first with cold and subsequently with hot water. Considerable quantities of boron and silicon can be thus obtained in a very short time.

University College, Liverpool.

THE CALORIMETRIC BOMB AS A COMBUSTION FURNACE FOR ULTIMATE ANALYSIS.

(Preliminary Note)

By ARNOLD EILOART, B.Sc.

This bomb, with its use in calorimetry, has been fully described by M. Berthelot ("La Force des Matières Explosives," 3rd Ed., i., 227); *Ann. Ch. et Phys.*, 6th Series, vi., 546). Briefly, it consists of a strong lidded crucible made of platinum cased in steel. A stopcocked tube passes through the middle of the lid, and near one side of it an insulated platinum wire, and the lid screws air-tight on to the crucible.

With this bomb M. Berthelot and his followers (see references above and *Ann. Ch. et Phys.*, 6th Series, x., 433) have proved several facts important for the purposes of this paper.

(1) Substances representative of some of the most important classes of substances containing carbon, as charcoal, methane, cellulose, glucose, saccharose, naphthalene, anthracene, phenol, benzoic acid, quinone, fumaric acid, may be burnt in the bomb with the utmost completeness and certainty. This is done by filling the bomb with oxygen at 24 atmospheres pressure, and igniting the substance therein by an electric current. Compounds containing nitrogen, *e.g.*, hydrocyanic acid, aniline (*Comp. Rend.*, cv., 1087), azoxybenzol, azobenzol, hydrazobenzol, and phenylhydrazine (*Comp. Rend.*, cvi., 1668) have been burned. Only in the case of aniline is it mentioned that any nitrous oxides were formed, and then their quantity was "very small."

(2) The bomb was capable of closure so perfect that not a bubble of gas escaped through the water in which the instrument was immersed during the operations.

These facts point the way to a method of ultimate analysis which would be an advance on any previous method, still greater than is effected by the bomb in calorimetry. The chief ground of doubting the utility of the bomb in analysis is that M. Berthelot himself nowhere mentions such an application of it; although he shows that the amount of carbonaceous gas burnt in the bomb may be estimated by weighing the CO_2 formed. For this he draws the gas, by means of a mercury pump, through a potash tube with guards and re-fills the exhausted bomb with air, the exhaustion through the potash tube and the re-filling being repeated three times. But this is by no means recommended as an analytical method. Moreover, the oxygen was saturated with water, so that no determination of water produced by combustion was made. Also, the original volume of air was left in the bomb, so that from the nitrogen some nitric acid was formed (30—4 m.grms.).

But drive out this air with dry oxygen, and why should not the water and CO_2 be estimated by simply introducing small weighed absorption vessels into the bomb before the experiment and noting the increase of weight after allowing time for complete absorption of the products of combustion and after displacing the oxygen with air? One of the chief objections would of course be expense. The original bomb of M. Berthelot contained 662 grms. of platinum, and its internal capacity was nearly 250 c.c. But since then a bomb described as "much smaller" has been found to answer. Moreover, the weight required for analysis is less than half that used for a calorimetric experiment, so that the size of the bomb may be reduced still further.

Many other difficulties will readily suggest themselves, though none I think insuperable. It is not my purpose to discuss them here, and it is not necessary to say much as to the importance of overcoming them, and making not only the discomforts of the combustion room, but the necessity for the room itself, a thing of the past. In the hope of hastening this result I publish this note, although I am very sensible that the value of such suggestions should be proved, and as a rule proved beforehand, by special experiment. For this I have unfortunately not yet had opportunity, but in the meantime it is well that investigators who are conducting experiments with the bomb should be asked to keep in mind the analytical as well as the calorimetric bearing of their work.

EXPERIMENTS UPON ALUM BAKING-POWDERS, AND THE EFFECTS UPON DIGESTION OF THE RESIDUES LEFT THEREFROM IN BREAD.

By Prof. J. W. MALLET, University of Virginia.

(Concluded from p. 278).

12. *Laboratory Experiments on the Effect of Treating a Liquid having the General Composition of Gastric Juice with Aluminum Hydroxide and Phosphate.*

Some light seems to be thrown on the nature of the interference with digestion of these aluminum compounds by a few experiments made with an artificial gastric juice, prepared by dissolving 2·5 parts of (real) hydrochloric acid and 3 parts of a pretty easily soluble "pepsin" in water enough to produce 1000 parts of the liquid.

A weighed quantity (about 50 grains) of either aluminum hydroxide or aluminum phosphate, carefully prepared and dried at 212° F., as described above (10), was added to a quantity of this liquid containing somewhat more hydrochloric acid than would suffice for complete solution, and the mixture allowed to stand, with occasional shaking, in a stoppered glass flask at about the temperature of the human body (98° or 99° F.) for a period which might be taken to represent something like the term of gastric digestion (2 or 2½ hours). The liquid was then filtered and a definite fraction of it evaporated to dryness at a low temperature over a water-bath, and the residue dried at 212° F. and weighed. This residue was afterwards heated to redness in the air until all water was expelled and all organic matter burned off, and a second weighing made. In like manner the undissolved matter left upon the filter was dried at 212°, weighed, heated to redness in the air, and again weighed. A definite portion of the original liquid (artificial gastric juice) which had not been treated with either of the aluminum compounds was also, for the purpose of comparison, evaporated to dryness, the residue dried at 212°, weighed, burned, and weighed again. And, finally, weighed portions of the particular lots of aluminum hydroxide and aluminum phosphate employed were treated in the same way, and the loss of weight at 212°, and after heating to redness, ascertained.

From the data thus obtained it appeared that in each case a part of the aluminum was dissolved by the feebly acid liquid, while on the other hand a part of the organic matter used as pepsin was rendered insoluble and left with the undissolved portion of the aluminum compound present. When aluminum hydroxide was used from 47·3 to 61·8 per cent of it was dissolved, from 5·6 to 14·5 per cent of the pepsin being at the same time precipitated or thrown down from the solution. When aluminum phosphate was used the proportion of it taken up by the liquid ranged from 38·2 to 49·1 per cent and from 25·8 to 32·9 per cent of the pepsin was rendered insoluble. These figures represent but approximate quantitative results for the organic matter precipitated, as it was found extremely difficult to secure equal drying of the materials weighed, and moreover in the case of the aluminum hydroxide, added to the artificial gastric juice, a turbid gelatinous liquid was produced which it was impossible to filter to a state of perfect clearness. It was shown, however, distinctly that there was a double effect on the liquid treated, both the principal constituents of natural gastric juice being influenced; the hydrochloric acid was in part

charged with the aluminum used, taken up in soluble form; and there was simultaneous removal from solution of the organic matter represented by the digestive ferment pepsin. This double effect may fairly be taken to indicate impairment of digestive efficacy of the natural gastric juice if exposed to similar treatment.

13. *Probable Similar Relation of the Aluminum Compounds Experimented on to the Soluble Organic Matter of Food as to that of the Gastric Juice.*

Although I have not as yet made any direct experiments on this point, it seems highly probable that the second of the two effects above noticed, namely, the partial precipitation in insoluble form of some of the organic matter of a liquid having the general composition of gastric juice, would be brought about also if soluble albumenoid and other forms of organic matter of *food* were similarly treated. The aluminum hydroxide or phosphate apparently entering into a sort of more or less loosely united compound with such organic matter, somewhat as is the case when, in dyeing, colouring substances of organic origin are fixed by aluminum mordants. If so, there would be apparent a further explanation of the impairment of digestion of the aluminum compounds in question, a part of the food, already in soluble form, being rendered insoluble on the one hand, while on the other the integrity of at least one of the most important digestive fluids of the body being interfered with, the power of dealing with the portion of the food requiring solution would be reduced.

14. *General Summary of the Conclusions Reached.*

The main points which seem to be established by the experiments under discussion are, briefly stated, the following:—

(*a*). The greater part of the alum baking-powders in the American market are made with alum, the acid phosphate of calcium, bicarbonate of sodium, and starch.

(*b*). These powders, as found in retail trade, give off very different proportions of carbonic acid gas, and therefore require to be used in different proportion with the same quantity of flour, some of the inferior powders in largely increased amount to produce the requisite porosity in bread.

(*c*). In these powders there is generally present an excess of the alkaline ingredient, but this excess varies in amount, and there is sometimes found on the contrary an excess of acid material.

(*d*). On moistening with water, these powders, even when containing an excess of alkaline material, yield small quantities of aluminum and calcium in a soluble condition.

(*e*). As a consequence of the common employment of calcium acid phosphate along with alum in the manufacture of baking-powders, these after use in bread-making leave at any rate most of their aluminum in the form of phosphate. When alum alone is used the phosphate is replaced by hydroxide.

(*f*). The temperature to which the interior of bread is exposed in baking does not exceed 212° F.

(*g*). At the temperature of 212° F. neither the "water of combination" of aluminum hydroxide nor the whole of the associated water of either this or the phosphate is removed in baking bread containing these substances as residues from baking-powder.

(*h*). In doses not very greatly exceeding such quantities as may be derived from bread as commonly used aluminum hydroxide and phosphate produce, or produced in experiments upon myself, an inhibitory effect upon gastric digestion.

(*i*). This effect is probably a consequence of the fact that a part of the aluminum unites with the acid of the gastric juice and is taken up into solution, while at the same time the remainder of the aluminum hydroxide or phosphate throws down in insoluble form the organic substance constituting the peptic ferment.

(*k*). Partial precipitation in insoluble form of some of the organic matter of food may probably also be brought about by the presence of the aluminum compounds in question.

(*l*). From the general nature of the results obtained the conclusion may fairly be deduced that, not only alum itself, but the residues which its use in baking-powder leaves in bread, cannot be viewed as harmless, but must be ranked as objectionable, and should be avoided when the object aimed at is the production of wholesome bread.

A NEW METHOD OF CHEMICAL ANALYSIS IN WHICH CAPILLARY ATTRACTION PLAYS AN IMPORTANT PART.

By CHARLES W. PHILLIPS, Cincinnati, Ohio.

Invented in 1872, but not made known on account of the many difficulties arising in connection therewith.

The first difficulty was to obtain pure chemicals. I do not say that I have them even now, so that in my work there are probably some errors that will have to be corrected at some future time, but the many beautiful, characteristic, and delicate reactions have induced me to make the matter public at this time with the hope that some one with better facilities at command may supply what I have omitted and verify what I have done.

The second difficulty was to obtain pure paper. For many years I hunted for a paper that would give even ordinary satisfaction, but could not find it. Recently I received a sample of incomparable filtering paper, which I found admirably adapted to the purpose, and have used it in these experiments.

These difficulties having now been largely overcome, I shall proceed to describe the reactions of all the important metals of the 6 groups with 4 reagents, making in all 116 reactions, leaving many curious and beautiful reactions with special reagents for some future paper. Believing this scheme of vast importance, I expect to develop it as rapidly as possible and hope to be able to adapt it to quantitative work. One of the principal advantages of this method is that experiments can be filed away for future reference, and in medico-legal investigations the actual evidence can be carried into court and filed away with other legal documents. I have on hand some experiments made sixteen years ago, in which the majority of the reactions are as distinctly visible as the day they were made.

If you wish to verify the following reactions, first prepare your test-papers as follows:—

Chemically pure white filtering paper, having a close grain, is dipped in a 10 per cent solution of ferrocyanide of potassium, laid on a pane of glass and dried in the open air or preferably in a drying oven at 150° F. Then prepare a 10 per cent solution of neutral chromate of potassium, also one of bromide of potassium, and one of hyposulphite of sodium, and proceed with each as before.

Having prepared your test-papers, rule them off in small squares, or otherwise with a lead pencil, and mark each block or space with the symbol of the metal you intend to apply to it. Place your papers on a clean pane of glass, and after once you commence to apply your tests the papers *must not be moved* until perfectly dry. Take a piece of glass tubing seven inches long and $\frac{3}{16}$ inch inside diameter, draw it out to a point and file off the point, then hold it in the flame constantly rotating until it forms a perfectly *round* end with an aperture of about $\frac{1}{50}$ inch. A half-inch of liquid drawn up into this tube is amply sufficient for 25 different tests.

Dip your tube in the solution to be tested, say potass. sulph., draw up a little of the liquid, wipe off the outside of the tube with a towel, and place the tube vertically upon the square marked K on each one of your test-papers; then blow out any liquid remaining in the tube;

throw into the larger end of the tube a few drops of distilled water from a wash-bottle, and blow it out as before; this will serve to clean the tube, which must be done very carefully before dipping into another solution. Proceed in this way with all the metallic elements. The following are the reactions with ferrocyanide of potassium test-paper as I have observed them. I have no doubt many chemists will at once assert that the blue reactions recorded are due to iron as an impurity, but I have as yet been unable to find chemicals that would not give these reactions. These reactions may be due to the acid radical and not to the metal. The peculiar rings and halos are not characteristic of the ferrocyanide of iron.

K.—No reaction, white centre washing out to a yellowish ring.

Na.—No reaction, white centre washing out to a yellowish ring.

NH_4.—White centre washing out to a pale blue ring which finally turns green.

Ba.—White centre washing out to a light yellow ring.

Sr.—White centre washing out to a thin olive-grey ring.

Ca.—White centre washing out to a pale yellow ring.

Mg.—White centre washing out to a yellow and finally a citron-yellow ring.

Al.—A pale blue homogeneous centre, surrounded by a white ring, and washing out to a thin greenish ring.

Cr.—Pale blue centre, surrounded with a pale greenish ring, and a thin green ring and a green halo.

Zn.—A homogeneous white spot.

Mn.—A very light brown centre, surrounded by a white ring, and that surrounded by a light yellowish-brown ring.

Ni.—A grey centre, surrounded by a white ring and then by a thin light yellow-brown ring.

Co.—A dark purple centre with rosy purple fringe, surrounded by a thin blue ring, followed by a thicker white ring, followed by another thin blue ring.

Fe''.—A sky-blue centre, surrounded by a paler blue fringe, surrounded by a white ring and then a grey ring.

Fe'''.—A dark blue centre, surrounded by a navy-blue ring, surrounded by a dark blue fringe.

Ag.—A reddish brown centre, with a lighter fringe surrounded by a white ring, surrounded by a citrine ring.

Hg'.—A Nile-green spot, changing sometimes to a green centre and sometimes to a white centre. When the centre is green it is surrounded by a white ring and then by a greenish yellow ring; when the centre is white it is surrounded by a broad pale bluish green and then a thin greenish yellow ring.

Pb.—A very light neutral grey centre, surrounded by a broad white ring and a narrow lemon-yellow ring.

Hg''.—A light pale blue centre, surrounded by a white ring, surrounded by a light heliotrope ring, surrounded by a thin citrine coloured ring.

Bi.—A light blue, changing to a sage-green centre with a whitish edge, surrounded by a bluish grey ring, surrounded by a thin Vandyke brown ring, resembling the margin of a crenate leaf, surrounded by a broad sage-green ring and a broad blue halo changing to yellow and vanishing.

Cu.—A reddish brown or terra-cotta spot, with serrulate margin.

Cd.—A pale blue homogeneous centre, surrounded by a white ring, surrounded by a thin citrine ring. The margin is entire. Is scarcely distinguishable from *Al*, only that the white ring is not so broad, and on close inspection the outside ring does not have so much greenish cast.

Au.—A mottled cream and ashes-of-roses centre, surrounded by a broad pea-green ring, surrounded by a broad old-gold coloured ring with a distinct undulate margin.

Pt.—A whitish green centre with deltoid chocolate-coloured spots in the margin, surrounded by a lemon-yellow ring, surrrounded by a thread-like old-gold coloured ring.

Sn''.—A pale blue centre, surrounded by a broad white ring, surrounded by a distinct thread-like crenate green border, surrounded by a bluish halo.

Sn''''.—A large heliotrope centre, surrounded by a light blue halo.

Sb.—A dark blue centre, irregular margin, surrounded by a light blue ring, surrounded by a distinct thread-like greenish ring, surrounded by a very large light blue halo, its diameter being three or four times the diameter of the dark blue centre.

As'''.—At first a delicate flesh colour, changing to white, surrounded by a thin yellow ring.

As''''.—At first a delicate salmon, changing rapidly to white, surrounded by a thin yellow ring.

Reactions with Neutral Chromate of Potassium.

K.—A white centre, surrounded by a broad pale yellow ring and a raised thin yellow ring.

Na.—A white centre, surrounded by a scarcely perceptible yellow ring.

NH_4.—An indistinct white centre, surrounded by a broad pale yellow ring, surrounded by a broad orange-yellow ring.

Ba.—A pale yellow centre, surrounded by a distinct white ring, surrounded by a broad yellow ring.

Sr.—A white centre, surrounded by an indistinct yellow ring.

Ca.—A white centre, surrounded by distinct salmon-yellow ring.

Mg.—A white centre, surrounded by a lemon-yellow ring.

Al.—A a peculiar very light lavender-grey coloured centre, surrounded by an orange-yellow ring, then by a yellow ring and a raised thin sulphur-yellow ring.

Cr.—A brownish lavender centre, surrounded with a pure lavender ring, surrounded by a thin serrated garnet ring with a thin orange-yellow margin.

Zn.—Yellow centre, surrounded with a white ring, surrounded with an orange-yellow ring, then with a lemon-yellow ring, and with a raised thin greenish yellow ring.

Mn.—A single dark-coloured spot, the size of a pin point, surrounded by a speckled surface composed of white, yellow, and amethystine flakes, surrounded by an irregular serrated or stellated amethyst border, surrounded by a broad brownish yellow ring and a narrow lemon-yellow ring, surrounded by a thin greyish yellow ring. This reaction is very characteristic.

Ni.—A leather-coloured centre, surrounded by a clouded white ring and a broad brownish red ring.

Co.—A homogeneous centre of a colour resembling scorched paper, surrounded by a thread-like ring of deep garnet, surrounded by an orange-yellow ring.

Fe''.—A plum-coloured spot with a metallic lustre. No rings.

Fe'''.—A rich gold or orange-yellow centre, surrounded by a pale yellow ring and a thin orange-red or brick-coloured ring, with a slight orange halo.

Ag.—A circular magenta centre of surpassing beauty, with a scalloped border of lighter tint, surrounded by a white ring, and a yellow ring, and a thread-like raised yellow ring. This reaction is very characteristic.

Hg'.—A fiery brick-red circular centre, surrounded by an irregular ring of lighter tint, surrounded by a white ring, an orange ring, and a raised lemon-yellow ring. Almost as characteristic as the preceding.

Pb.—A yellow centre, surrounded with a yellowish white ring, a tawny-coloured ring, and a slightly raised thread-like lemon-yellow ring, surrounded by an indistinct tawny-coloured halo.

Hg''.—A light salmon centre, surrounded by a very light salmon ring, a tawny-coloured ring, and a thin raised lemon-yellow ring.

Bi.—A heliotrope centre, surrounded by a yellow ring, and terra cotta margin with an orange halo, changing, on drying, to an almost white centre, surrounded by a very

narrow yellow ring, and a dark brown thread-like ring, and an orange halo.

Cu.—Deep maroon, changing to a light bismarck, which on drying becomes whiter, surrounded by a light terra-cotta ring, surrounded by a thread-like ring of bismarck brown, and a very narrow orange border.

Cd.—A tawny-coloured centre, surrounded by a ring of lighter tint and a broad orange ring, and then a yellow ring.

Au.—A mottled centre, composed of light yellow and dark lavender-grey spots, surrounded by a ring of darker shade, resembling slate colour, and a lemon-yellow ring and a raised thread-like yellow ring.

Pt.—A tawny coloured centre, surrounded by a lighter ring, surrounded by an orange ring and a lemon-yellow ring with a raised thread-like border.

Sn''.—A bluish white centre shading off through light yellow into light brown, surrounded by a dark brown thread-like ring, forming a ragged or dentate margin with an orange halo.

Sn''''.—A white shading off into a more distinctly bluish colour, surrounded by a dark citron coloured ring with irregular edge and an orange halo.

Sb.—A white shading off into a greenish white centre, surrounded by a thread-like scalloped cinnamon-brown ring, surrounded by a greenish halo shading off into brown, orange, and yellow, the diameter being twice the diameter of the centre.

As'''.—A light green centre, surrounded with a darker green ring, surrounded by a broad yellow-green ring.

As''''.—A light green, changing to yellow, surrounded by white, surrounded by a thin light yellow-green ring, surrounded by a yellow ring with raised edge.

Reactions with Bromide of Potassium.

K, Na, NH_4, Ba, Sr, Ca, Mg, Al, Cr, Zn, Mn, Ni, and Pb produce no perceptible reaction.

It is a peculiarity of this reagent that all the rings have entire margins, none have rough or jagged edges.

Co.—A very light rose-coloured centre with a thin light margin and a brownish white halo.

Fe''.—A very light yellow-grey centre, surrounded by a broad cream-coloured ring and a thread-like ring of yellow grey. No halo. Sometimes the cream-coloured ring changes to orange. In this instance, only once in five experiments.

Fe'''.—A bright yellow-brown spot, by transmitted light blood-red. No rings; no halo.

Ag.—A yellow-white centre, which turns a dark grey on exposure to light, surrounded by a broad white ring with raised edge.

Hg'.—A very white centre, surrounded by a broad ring the colour of the paper, surrounded by a thin raised white ring. Centre does not darken by exposures to light.

Pb.—Hardly ruffles the paper; can scarcely be seen.

Hg''.—A large centre the colour of the paper, surrounded by a thin white ring.

Bi.—A beautiful greenish-white centre, surrounded by very thin yellow and orange rings, and a delicate, light salmon halo, whose diameter is twice that of the greenish-white centre.

Cu.—A pale blue-green centre, surrounded by a broad light brown ring. Very characteristic.

Cd.—A white centre, surrounded by a very faint brownish-white ring, surrounded by a distinct white ring.

Au.—An orange centre somewhat resembling the ferric reaction but lighter in tint, and appearing orange by transmitted light, having a faint yellow edge, surrounded by a ring the colour of the paper, and that by a white ring. The ring just inside the white ring changes to light blue.

Pt.—A lemon-yellow centre. Surrounded by a faint brownish ring, which by transmitted light looks quite distinct, surrounded by a light yellow ring.

Sn''.—A white spot, hardly perceptible, but having a faint yellow halo when viewed by transmitted light.

Sn'''.—A white spot with a very light fawn-coloured halo.

Sb.—A white centre, surrounded by a thread-like orange ring, surrounded by a faint yellow halo, whose diameter is three times the diameter of the centre. Best seen by transmitted light.

As'''.—White, by transmitted light a series of light drab concentric rings.

As''''.—White, by transmitted light a light drab, somewhat lighter than above.

Reactions with Hyposulphite Soda.

K, Na, NH_4, Ba, Sr, Ca, Mg, Al, Cr, Zn, Mu, no reaction.

Ni.—White centre, surrounded by a Vandyke brown stellate ring, no halo. Quite characteristic.

Co.—Large white centre, surrounded by a thin dark green ring, changing to bronze-green, surrounded by a sky blue ring. Very characteristic.

Fe''.—A very light brown or light salmon centre, surrounded by a broad light brown ring.

Fe'''.—A sulphur yellow centre, surrounded by a light brown and then a darker brown irregular ring.

Ag.—A yellow centre rapidly changing to brown and then to dark brown, surrounded by a light brown irregular ring. Characteristic.

Hg'.—A black centre, surrounded by an irregular grey ring. Characteristic.

Pb.—No reaction, except a very pale yellow colour by transmitted light.

Hg''.—At first produces a white spot, which changes to a variegated spot, having lemon-yellow and light brown irregular spots, surrounded by a white ring and an irregular slate-coloured ring.

Bi.—A light centre, with yellow-brown irregular ring. The whole changing to a dark reddish brown.

Cu.—A greenish yellow centre, surrounded by thin yellow and orange rings. The centre finally changes to a very light copper colour, surrounded by a broad greenish yellow ring, and that by a thin yellow and orange ring.

Cd.—A white centre, with a very faint brownish white ring, hardly perceptible, except by transmitted light.

Au.—A peculiar light brownish grey splattered spot mingled with light yellow, almost indescribable, but very characteristic; no rings.

Pt.—A light brown or brownish grey mottled centre, surrounded by a white ring, surrounded by a light brown ring.

Sn''.—A white centre, surrounded by a broad faint yellow or greenish yellow ring,

Sn''''.—Same as above, only with a thread-like white ring on the outer edge.

Sb.—A white centre, surrounded by a thin yellow and orange-yellow ring.

As'''.—No perceptible reaction.

As''''.—No perceptible reaction. — *Pharmaceutical Record*, Nov. 1, 1888.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, December 6th, 1888.

Mr. William Crookes, F.R.S., President, in the Chair.

Messrs. Lewis Edmunds, J. B. Readman, and J. Cowper were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Charles Lightfoot Barnes, The Steps, Bromsgrove, Worcester; Albert Cooper, Grimstone Lawn, Haven Green, Ealing; William Hepworth Dixon, Heatherdale, Woodford Green, Essex; B. S. Gott, B.A., Wesley

College, Sheffield; Frederick Charles Garrett, B.Sc., 4, Kempson Road, Walham Green, S.W.; Robert J. Gow, Halebank Terrace, Ditton, Widnes; Edward Gudeman, Ph.B., P.O. Box 3001, New York City; Allan Twistleton Hall, Inglebank, Newlands, Hull; John A. Hall, 126, Lloyd Street, Greenhays, Manchester; Cecil Leigh, care of A. H. Allen, 67, Surrey Street, Sheffield; Arthur Lloyd MacLeroy, M.A., 12, George Street, Bathwick Hill, Bath; Frank K. Peace, Monton Grange, Eccles, near Manchester; Charles W. Priestley, B.Sc., Abbey House School, Tewkesbury; John Provis, Poldice House, North Adelaide, South Australia; Edgar Richards, Office of Internal Revenue, Washington, D.C.; Siegfried Ruhemann, Ph.D., M.A., University, Cambridge; Walter Venis, Benares, India.

The following were elected Fellows of the Society:—Messrs. Charles M. Adams, John Hope Belcher, B.A., William Berry, William Dunsmore Bohm, Frank Bower, James Edward Brunker, George Alexander Byrn, John Morrow Campbell, Vaughan Cornish, B.Sc., William Douglas, Arthur George Everard, Henry Forth, Frederick Bickell Guthrie, John Hansfield, Urban Arthur Jackson, Alfred Battye Knapps, Oscar Lowman, B.A., Ph.D., William Marshall, George Edward Perry, Hubert N. B. Richardson, John S. Rigby, John Sanderson, Thomas Oliver Sandolt, William Jay Schieffelin, Arthur Landauer Stern, William Taylor, Charles Turner, John Laurence Van-Geyzel, I. T. Ainslie Walker, Edward Dalrymple Walrond, B.A., Frederick W. Warrick, Edward J. Way, Ernest W. Whieldon, R. W. Woosnam.

The following papers were read:—

86. "*A Method of Determining Vapour-density, Applicable at all Temperatures and Pressures.*" By William Bott, Ph.D., Berkeley Fellow of Owens College.

The apparatus consists of a large Victor Meyer's bulb, carrying a detachable head-piece, which can be connected with the air-pump. The neck of the bulb communicates with a mercury pressure-gauge, which again is connected with a wide measuring tube attached to an adjustable mercury reservoir. The experiment is conducted as follows. The substance having been placed in the head-piece of the vessel, the latter is heated until the volume has become constant. The apparatus is then exhausted as far as may be requisite, and the reservoir so adjusted that the graduated measuring tube is filled with mercury. The pressure indicated by the gauge having been carefully noted, the substance is allowed to drop into the hot part of the vessel, and the surplus pressure produced by its evaporation is removed by drawing off an equivalent volume of air into the measuring tube until the initial pressure in the gauge has been restored. From the volume of gas measured in the graduated tube, the density referred to hydrogen is obtained by the formula—

$$d = 8484893 \frac{S(1+0{\cdot}00367t)}{V\,P}.$$

S = weight of substance; V = volume of gas in measuring tube; P = pressure of gas in measuring tube; t = temperature of gas.

Discussion.

Prof. Ramsay, remarking on a statement made by the author that he proposed to make use of the apparatus in studying the influence of pressure on dissociation, said that recent investigations had shown that the Victor Meyer form of apparatus was by no means a suitable one for the study of such problems; and he expressed the opinion that for this reason results such as those recently published by Nilson and Pettersson could not be accepted as final.

87. "*Some Derivatives and New Colouring-matters of α-Pyrocresol.*" By William Bott, Ph.D., and J. Bruce Miller.

Trichlor-α-pyrocresol, $C_{15}H_{11}Cl_3O$, produced by direct chlorination of pyrocresol, forms fine, silky needles, soluble in boiling benzene and chloroform, insoluble in alcohol and ether; it melts at about 225°.

Dinitro-α-pyrocresol oxide, $C_{15}H_{10}(NO_2)_2O_2$, is obtained from α-pyrocresol oxide by careful nitration in the cold and subsequent treatment with alcohol. It forms yellowish white crystals, sparingly soluble in acetic acid and freely in hot nitrobenzene; it melts at 235°.

Tetramido-α-pyrocresol oxide, $C_{15}H_8(NH_2)_4O_2$, is obtained by reduction in acid solutions from the corresponding tetranitro-derivative; it is a greenish yellow powder, soluble in acids, and melts above 300°.

Diamido-α-pyrocresol oxide, $C_{15}H_{10}(NH_2)_2O_2$, prepared from dinitro-α-pyrocresol oxide, resembles the tetranitro-derivative in its properties.

Both amido-compounds can be diazotised, and the diazo-salts interact with phenols in alkaline solution. Two oxyazo-compounds have thus been obtained from β-naphthol, representing the first colouring-matters prepared from pyrocresol. Both interact with concentrated sulphuric acid in a characteristic manner, resembling safranine in their behaviour. The colouring-matters in the pure state are dark red powders, insoluble in water; they can be converted into soluble sulphonic acids by treatment with fuming sulphuric acid: the solutions dye silk and wool a fine maroon and salmon colour respectively.

By the action of ammonium sulphide upon tetranitro-α-pyrocresol oxide in alcoholic solution, a red and a yellow substance have been obtained, which are evidently azo-derivatives, but have not yet been examined more closely. The yellow substance is somewhat soluble in hot water, the solutions dyeing silk a fine yellow shade.

88. "*Berberine.*" By W. H. Perkin, Jun.

Several analyses of the base and also of its chlorhydride showed that these substances were not adapted to the purpose on account of their containing water of crystallisation, which can only partially be removed by dehydration: a fact which has been previously noticed by other chemists. Berberine appears to crystallise with 5 to 5½ mol. props. of water, 2 of which remain when the substance is dried at 100° till constant. Berberine chlorhydride, dried over sulphuric acid in a vacuum at a temperature of about 40°, has the formula $C_{20}H_{17}NO_4HCl + 2H_2O$. The chloroplatinate, iodhydride, and nitrate, however, are well adapted for analytical examination, and the results which they afford agree closely with those required on the assumption that berberine is $C_{20}H_{17}NO_4$.

When oxidised with an excess of potassium permanganate in slightly alkaline solution, berberine yields, as principal product, hemipinic acid, $C_{10}H_{10}O_6$, as Schmidt and Schilbach (*Arch. Pharm.*, [3], 164—170) have already shown. In view of the interesting results lately obtained by Goldschmiedt in his examination of hemipinic and methemipinic acids, the author has carefully re-examined the hemipinic acid from berberine, and is convinced that it is identical with that obtained by the oxidation of narcotine. The acid from berberine contains two (OCH_3) groups; on fusion with potash it yields protocatechuic acid, and on distilling it with ethylamine, hemipinethylimide, melting at 96°, is formed. This latter substance possesses all the properties of the hemipinethylimide obtained by Liebermann by the action of ethyl iodide on the potassium salt of hemipinimide (from narcotine), and thus the identity of the two hemipinic acids from berberine and narcotine is proved.

Besides hemipinic acid, small quantities of at least two other acids are formed by the oxidation of berberine; one of these melts at 238—242°, and appears to be identical with berberonic acid (or carbocinchomeronic acid ?).

If berberine is carefully oxidised with a limited quantity of permanganate, a number of new substances are formed, three of which have already been obtained in a state of purity: a new acid, $C_{20}H_{17}NO_9$, which melts at 143°, and two neutral substances, $C_{20}H_{17}NO_8$ and $C_{20}H_{16}NO_7$, all of which yield protocatechuic acid (berberinic acid ?) on

fusion with potash. The compound $C_{20}H_{17}NO_8$ melts at 236°; it is insoluble in cold solutions of alkaline carbonates, but dissolves in potash, ammonia, &c., forming well-defined salts. The silver salt appears to have the formula $C_{20}H_{15}NO_8Ag_2+4H_2O$.

The compound $C_{20}H_{15}NO_7$ (?) melts at 150° and is insoluble in alkalies.

When heated with a fuming aqueous solution of hydrogen iodide, berberine yields methyl iodide and a phenolic substance which, from the analysis of its sulphate, appears to have the formula $C_{18}H_{13}NO_4$, being derived from berberine by the displacement of two methyl-groups. Several determinations of the number of (OCH_3) groups by Zeisel's method have shown that there are two such groups present in the berberine molecule.

The author has also examined berberinic acid—one of the acids obtained by Hlasiwetz and Gilm (*Jahresbericht*, 1864, 407), by fusing berberine with potash. This acid is decomposed on distillation into carbon dioxide and homopyrocatechol—a decomposition which proves that the acid must be looked upon as a carboxylic acid of this phenol.

The behaviour of berberine towards methyl and ethyl iodides, benzylchloride, &c., has also been studied; it appears in opposition to the results of Henry (*Annalen*, cxv., 133), that the alkaloid does not form additive compounds with these substances.

89. "*The Action of Ammonia on Some Tungsten Compounds.*" By Dr. S. Rideal, D.Sc.

Wöhler, in 1858, found that a compound containing nitrogen, hydrogen, and oxygen was obtained by the action of ammonia on heated tungstic oxide, and also a compound containing nitrogen and hydrogen from ammonia and tungsten chloride; analyses of different specimens, however, gave varying results.

According to the author's experiments, ammonia effects the removal of a part only of the oxygen in tungstic oxide, and the black products vary greatly in composition, the average of many analyses agreeing best with the formula $W_5N_6H_3O_5$. When tungstic oxide is heated with ammonium chloride a similar black product is obtained. The amount of tungsten in different specimens varies between 83·9 and 81·0 per cent, the amount of nitrogen being less than in the compounds formed by means of ammonia; the mean composition of the products in this case may be represented by the formula $WN_2 \cdot WO_3$.

Ammonia acts on the yellow tungsten oxydichloride in the cold, forming ammonium chloride and a dark brown product which contains no nitrogen, and appears to consist of the dioxide WO_2; this interaction is similar to that of ammonia and chromyl dichloride.

Ammonia also acts on the red tungsten oxytetrachloride, forming a black compound; this contained 88·9 per cent of tungsten, but the amount of material was insufficient for a determination of the nitrogen. It seems probable that the product is the same as that found when ammonia acts on the hexachloride; *i.e.*, the nitride W_2N_3.

The action of ammonia on tungsten hexachloride was studied by Wöhler, who was of opinion that two compounds were formed, viz., $2WN_2 + W(NH_2)_2$ and $2WN+W(NH_2)_2$. This conclusion was based on determinations of tungsten and nitrogen in the samples prepared, but hydrogen was not estimated. The author has re-examined the black powder formed in the interaction in question, and has obtained numbers agreeing with those of Wöhler for the tungsten and nitrogen percentages, but he considers that the final product is free from hydrogen, and that it is the nitride W_2N_3.

Dry ammonia has no action on finely divided tungsten, even at a red heat, and seems also to be without action on the blue oxide.

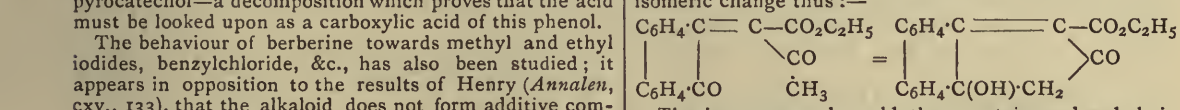
Discussion.

The President drew attention to the anomaly involved in the use of the name *Tungsten* and the symbol W.

90. "*Condensations of α-Diketones with Ethylic Acetoacetate.*" By Francis R. Japp, F.R.S., and Felix Klingemann, Ph.D.

In a paper entitled "Condensations of Glyoxal with Ethylic Malonate and Ethylic Acetoacetate," by Max Polonowsky (*Annalen*, ccxlvi., 1), it is stated, as a reason for undertaking the investigation, that only the condensations of these ethereal salts with *mon*aldehydes and *mono*ketones have hitherto been studied. Polonowsky has evidently overlooked the fact that the condensation of a *di*ketone—phenanthraquinone—with ethylic acetoacetate has been described by Japp and Streatfeild (*Trans.*, 1883, 27). The authors, therefore, wish to point out that they are engaged in investigating the condensation-product, $C_{20}H_{16}O_4$ — ethylic phenanthroxylene-acetoacetate—obtained by Japp and Streatfeild. The following interactions have been studied: —

By heating with *formic acid* (sp. gr. 1·22) at 130° the condensation compound is transformed into an isomeride crystallising in short needles melting at 177°. (Melting-point of the original condensation-product, 185°.) A study of the new compound leads the authors to represent the isomeric change thus:—



The iso-compound would thus contain a closed chain of 5 carbon atoms. It yields a hydrazone,—

$$C_{20}H_{16}O_3(N_2HC_6H_5),$$

melting with decomposition at 210—212°; whereas phenylhydrazine and the condensation product do not interact under ordinary conditions. The iso-compound is converted by acetic anhydride into an acetyl-derivative, $C_{20}H_{15}(C_2H_3O)O_4$, which crystallises from benzene in thick needles melting at 165—170°. The iso-compound is converted by hydrolysis with aqueous caustic soda into the corresponding monobasic acid, $C_{18}H_{12}O_4$; this crystallises from alcohol in satiny needles, which melt at 267—269° with decomposition. The condensation compound cannot be hydrolysed under these conditions (*vide infra*). With bromine the iso-compound gives a monobromo-derivative, $C_{20}H_{15}BrO_4$, which melts at 217° with decomposition, instead of the expected additive dibromide.

By heating with glacial *acetic acid* at 130—140°, the condensation-product yields a mixture of three compounds: (1.) A compound of the formula $C_{20}H_{14}O_3$, which crystallises in white silky needles, insoluble in boiling acetic acid, and which decomposes without previous fusion at about 285°; this is formed with elimination of 1 mol. of water. (2.) The acetyl-derivative, $C_{20}H_{15}(C_2H_3O)O_4$ (m. p. 165—170°), already mentioned as obtained from the iso-compound. This acetyl-derivative gives with phenylhydrazine the same hydrazone, and with caustic soda the same monobasic acid as the iso-compound, the acetyl-group being in both cases eliminated. (3.) A compound of the formula $C_{40}H_{28}(C_2H_3O)_2O_7$, which crystallises from acetic acid in rectangular plates melting at 227°; this is formed only in small quantity—apparently by elimination of 1 mol. of water from 2 mols. of the acetyl-derivative.

Propionic acid converts the condensation-product into the before-mentioned compound, $C_{20}H_{14}O_3$, together with a propionyl-derivative, $C_{20}H_{15}(C_3H_5O)O_4$, melting at 134°.

By boiling the condensation-product with *sulphuric acid* diluted with twice its weight of water, it is converted quantitatively into the iso-compound $C_{20}H_{16}O_4$, already described as obtained from formic acid (*vide supra*).

By boiling the condensation-product with *alcohol* to which a few drops of *sulphuric acid* have been added, it is converted into the compound $C_{20}H_{15}(C_2H_5)O_4$, which crystallises from alcohol in rectangular or prismatic crystals melting at 143—144°. But if the condensation-product is heated with a mixture of equal weights of alcohol and sulphuric acid at 100°, it gives a compound, $C_{17}H_{12}O_2$, which crystallises from phenol in microscopic six-sided plates, melting with decomposition at 276—277°; $C_{20}H_{16}O_4+H_2O=C_{17}H_{12}O_2+C_2H_5 \cdot OH+CO_2$.

By warming it with an *alcoholic solution of hydrogen chloride*, the condensation-product is converted into the compound $C_{20}H_{15}ClO_3$, which crystallises from a mixture of benzene and light petroleum in lustrous flat needles melting at 140°.

The condensation-product is hydrolysed by *alcoholic potash* in the cold; heating must be avoided. The resulting acid is unstable, and has not been obtained in a crystallised condition; when freshly precipitated it dissolves in alkaline carbonate, but loses this property on standing. It dissolves in cold alcohol; on heating, the solution deposits a compound, $C_{17}H_{12}O_2$, which crystallises from phenol in star-shaped groups of needles, melting with decomposition at 259°; this is isomeric with the compound already described as obtained by heating the condensation-product with a mixture of equal weights of sulphuric acid and alcohol.

The authors have also obtained a condensation compound from benzil and ethylic acetoacetate. It appears to belong to a different class from the phenanthraquinone compound. They also intend to study the condensation of ethylic benzoylacetate with benzil and phenanthraquinone.

91. "*Thionyl Thiocyanate.*" By G. C. McMurtry.

Thionyl thiocyanate, $SO(SCN)_2$, is prepared by the action of thionyl chloride, dissolved in cold carbon bisulphide, on mercuric thiocyanate. It is an orange-coloured amorphous powder, insoluble in cold water, alcohol, ether, petroleum, phenol, chloroform, amyl alcohol, and acetic acid, but readily soluble in carbon bisulphide, and to a less extent in hot benzene.

92. "*Mercuric Chlorothiocyanate.*" By G. C. McMurtry.

Mercuric chlorothiocyanate, $ClHg{\cdot}SCN$, or—

$$HgCl_2{\cdot}Hg(CSN)_2,$$

may be obtained by crystallising mercuric thiocyanate with mercuric chloride. It crystallises in monosymmetric prisms, sparingly soluble in cold water, but readily soluble in hot water and in alcohol.

93. "*The Action of Chromium Oxychloride on Pinene.*" By G. G. Henderson, B.Sc., M.A., and R. W. Smith.

The authors find that pinene and chromium oxychloride interact very readily, forming a solid compound of the formula $C_{10}H_{16}{\cdot}2CrO_2Cl_2$. This is decomposed by water, yielding an oil which may be purified by distillation with steam, and which has a composition expressed by the formula $C_{20}H_{33}OCl$. It is possible that this oil may be a mixture of the two compounds $C_{10}H_{18}O$ and $C_{10}H_{15}Cl$, but the authors were unable to separate it into two portions by steam-distillation; it is not attacked by alcoholic potash, does not combine with bisulphites, is unaffected by acetic chloride, and does not interact with either hydroxylamine or phenylhydrazine. When distilled under diminished pressure it loses the elements of a molecule of water, yielding an oil of the composition corresponding to the formula $C_{20}H_{31}Cl$.

94. "*Tectoquinone.*" By R. Romanis, D.Sc., Rangoon College.

In a former communication (*Trans.*, 1887) the author described a substance found in teak resin (*Tectonia grandis*), and also in the products of the destructive distillation of the wood, having the composition $C_{18}H_{16}O_2$, and the properties of a quinone. It may be separated from the tar by caustic soda, which dissolves the tar, leaving a curdy mass containing the quinone, mixed with a hydrocarbon of the composition C_nH_n, melting at 194°, and other substances. The quinone is separated by dissolution in boiling alcohol of 50 per cent, in which the other substances are insoluble; t separates as the liquid cools in a felted mass of soft woolly crystals; from strong alcohol it is deposited in oblique rhombic prisms of amber colour, resembling sulphur. It melts at 171°, sublimes slowly at ordinary temperatures, sensibly at 100° C., and rapidly near its melting-point. By careful heating between watch-glasses it can be sublimed without decomposition, condensing in yellow rhombic plates. It is a very stable substance, dissolving in sulphuric and nitric acids, and being precipitated unchanged on dilution; apparently it is not acted on by fused potash. On heating it with absolute alcohol and potash, a deep crimson solution is formed, which deposits bronze-coloured crystals on cooling; on exposure to moist air, or on mixing with water, the crimson solution turns green and yellow, and the quinone is re-precipitated. The quinone is reduced if heated with zinc and acetic or chlorhydric acid in a sealed tube at 150° C. The product is a resin soluble in alcohol and ether, the dilute ethereal solution showing a splendid blue fluorescence. A similar resinous product is formed by the action of iodine, phosphorus, and water, but in this case the principal products are volatile. These resinous products contain from 4·7 to 5 per cent of oxygen, showing that 40 per cent of the quinone is unreduced, and in fact it gradually separates from the resin in rhombic crystals. Analysis shows the composition of the reduction product to be $C_{18}H_{22}$ (m. p. 72° ?).

If the quinone be heated with soda-line and zinc, it yields a hydrocarbon melting at 194°, which crystallises from alcohol in four-rayed stars composed of twinned rhombic plates.

Dibromotectoquinone is obtained by the action of bromine at 100—140°. It crystallises in orange-yellow, slender needles, which are generally arranged in spherical clusters, soluble in ether and alcohol. On fusion it melts at 165°; with potash it gives a blue or purple melt: this dissolves in water, forming a purple solution, from which acids throw down a yellow flocculent precipitate, no doubt a dihydroxyquinone.

Dinitrotectoquinone is a yellow powder obtained by the action of nitrosulphuric acid on the quinone. It is converted by sodium-amalgam, or zinc and caustic soda, into a crimson substance.

If the quinone be heated for two hours with nitrosulphuric acid, and the solution be then diluted, a purple precipitate is produced, which dissolves in alkalies, forming a purple solution.

Tectoquinone may possibly be retenequinone, which has not yet been discovered. Retene melts at 99° C.; the product of the reduction of tectoquinone softens at 70—72°, but it is evidently a mixture.

95. "*The Decomposition of Nitroethane by Alkalies.*" By Wyndham R. Dunstan and T. S. Dymond.

The authors have been engaged during the present year in studying the action of alkalies and of certain reducing agents on nitroethane. They observed in October, 1887, that nitroethane is gradually decomposed at ordinary temperature by contact with potassium carbonate or its aqueous solution; at 80—90° the action is completed in a few hours. The chief products of the change are potassium nitrite and an oily liquid having the formula C_6H_9NO, which boils at about 170°, at a somewhat higher temperature decomposing with the formation of what appears to be a pyridine derivative. The compound is not attacked when heated for 48 hours in a closed tube with concentrated chlorhydric acid, neither is it appreciably affected by reducing agents. It is readily oxidised by permanganate. It does not seem to be either a nitroso- or isonitroso-derivative. This compound is apparently identical with that described by Götting (*Annalen*, ccxliii., 104), who obtained it in Geuther's laboratory by heating together propyl iodide, sodium nitroethane, and sodium ethoxide. Its ready formation, together with potassium nitrate, from nitroethane by contact with potassium carbonate, is likely to have an important bearing on the question as to the constitution of the paraffin nitro-compounds, and the authors therefore intend to continue the investigation. They are induced to publish the present preliminary notice by the appearance, in a recent number of the *Berichte* (November, 1888, p. 710), of an abstract of a paper by Sokolow in the *Russian Chemical Journal*. It is there shown that by heating nitroethane

to 100—130° in closed tubes with sodium hydroxide or carbonate, the compound C_6H_9NO, described by Götting, is produced, and that if an alkyl iodide is present it takes no part in the change. Neither sodium hydroxide nor sodium carbonate attacks nitroethane at ordinary temperatures.

PHYSICAL SOCIETY.

December 8, 1888.

Prof. Reinold, F.R.S., President, in the chair.

Dr. A. Gamgee, F.R.S., and Mr. A. P. Trotter, B.A., were elected members.

The following communications were read:—

"*Note on a Modification of the Ordinary Method of Determining Electro-magnetic Capacity.*" By Mr. J. W. W. Waghorne, D.Sc.

In determining capacity absolutely from the throw of a galvanometer and a steady deflection through a known resistance produced by the same battery, error may arise from the imperfect elasticity of the fibre (when short), and the resistances required are often greater than can be conveniently obtained. The latter difficulty may be overcome by taking a known fraction of the potential difference used for charging the condenser, to produce the steady deflection, and the former error may be reduced by observing the first swing due to the permanent current, instead of the steady deflection produced by that current. By adopting this latter device, the logarithmic decrement need not be determined, and the time required to make a measurement is considerably reduced. The formula for capacity (F) becomes—

$$F = \frac{t\, d_1\, b}{\pi\, G\, d_2\, a},$$

while t = periodic time in seconds, G = resistance of galvanometer circuit, d_1 and d_2 the throws due to the condenser charge and the permanent current respectively, and a and b the resistances in the battery circuit from the ends of which the potential differences used to produce d_1 and d_2 are taken.

The above expression is not strictly accurate, because the damping effects on open and closed circuit are not identical; but in the cases observed by the author where the damping is not serious, the difference is negligible. A modified form of Pohl's rocking key was shown, whereby the two throws d_1 and d_2 could be rapidly observed, and readings could be taken in opposite directions to eliminate error due to torsion of the fibre.

Dr. Thompson pointed out that error frequently arises from the capacity of the key being appreciable where small condensers are being used, but the author stated that the modification was not intended for such cases.

Prof. Ayrton remembered having used, in conjunction with Prof. Perry, the throw due to the permanent current instead of the steady deflection, when experimenting with condensers containing E.M.F's, and believed they abandoned it on account of the difference in decrement on closed and open circuits.

Mr. Sumpner regarded galvanometers with small differences in damping, on closed and open circuits, as unsuitable for ballistic purposes, and mentioned a case in which the latter was only half the former.

Mr. Boys considered the damping would be modified by having the condenser joined to the galvanometer terminals, and thought the decrement should be decidedly different from that on pure open circuit.

In thanking the author for his paper, the President said that any improved arrangements of well-known experiments or of lecture apparatus would always be gladly received, and reminded members that in bringing such before the Society they would be carrying out one of the chief objects for which it was founded.

"*On Some Facts Connected with the Systems of Scientific Units of Measurement.*" By Mr. T. H. Blakesley, M.A.

The author considers that the C.G.S. and Practical (Quadrant, Volt, Second) systems of units do not satisfy the requirements of a perfect system, in which the chief ends to be kept in view are:—1st, *Correlation*; 2nd, *Simplicity*; 3rd, *Comprehensiveness*; 4th, *Naturalness*; and 5th, *Convenience*.

In a properly *Correlated System* all the quantities considered should be so connected by the equations representing the laws of nature, that no coefficients are required in expressing any unit in terms of others; for *Simplicity*, quantities essentially the same should be measured by the same unit; and to be *Comprehensive*, the system should embrace all the physical ideas which occur; to be *Natural*, its units should be closely or decimally connected with natural units; and for *Convenience*, they should agree with established (though arbitrary) units, either actually or decimally.

In the two systems referred to, correlation has been more completely realised than any of the others, but simplicity is by no means satisfactory, and the want of comprehensiveness was discussed by Prof. Rücker at the last meeting. The "second" is unnatural in not being a decimal subdivision of the solar day, and the gramme is derived from the centimetre by assuming the density of water to be unity, whilst the inconvenience arising from the relation between the horse-power and the Watt or the erg is universally acknowledged.

Two general formulæ are given for converting magnitudes expressed in Practical and C.G.S. electro-magnetic measure into C.G.S. electrostatic units. Let k and h be the dimensions as regards length and mass when the quantities are expressed in the E.M. system, and n and q the corresponding numbers when expressed in the E.S. system, then 1 Practical unit $= 3^{n-k}\, 10^{10n-11q+k}$ Electrostatic C.G.S. units, and 1 C.G.S. electromagnetic unit $= 3^{n-k}\, 10^{10(n-k)+11(h-q)}$ Electrostatic C.G.S. units, the 3 arising from "v" being taken as 3×10^{10} c.ms. per second.

Though the formulæ may be found useful, the author thinks it would be far better to adopt one system for all measurements, and suggests a "Coalition System," in which "v" is taken as the unit velocity. If in this system the "second" be retained, then the unit of length will be 30 earth-quadrants, and if the quadrant be taken (as in the present practical system) as the unit of length, then the unit of time will be $\frac{1}{30}$ sec. The influence of such changes on present standards is then discussed, and the relation between the new unit of power and the horse-power (H.P.) found to be unsatisfactory.

To endeavour to bring the H.P. and the unit of power into decimal relation, the author expresses the physical quantities in terms of length, time, and power, from a table of which it is evident what units were affected by changing the unit of power, and tables of converting factors are given, when the latter were taken as 0·746 Watt or as 7·46 Watts.

The correlation of temperature θ with the units is considered to be best effected by defining it so that J = 1 in the equation $m\, l^2\, t^{-2} = J\, m\, c\, \theta$, when "the unit of temperature change would be that through which unit energy in the form of heat would raise a unit of matter possessing unit specific heat," and by choosing air at constant pressure as the standard substance, 1° C. = 10^7 C.G.S. (air) units.

A summary is given towards the end of the paper in which the union of the two electrical systems by choosing $\frac{1}{30}$ sec. as the unit of time is recommended, the effect of which is to make the unit of capacity $\frac{1}{900}$ Farad, and that of resistance 30 ohms. Before concluding, the author deprecates the practice of giving specific names to particular units, for, by so doing, subsequent necessary changes are made much more difficult.

Prof. Rücker expressed his opinion that temperature

would be best correlated by expressing it as energy, instead of making its dimensions $l^2 t^{-2}$ as suggested in the paper.

Dr. S. P. Thompson thanked the author for his prefix "megisto," denoting "multiply by 10^{12}. Referring to the choice of air as the standard for specific heat, he remarked that convenient coincidences were not always to be trusted, and that the specific heat of air depended on the pressure to which it was subjected.

Some Improved Polarising Apparatus for Microscopes were exhibited and described by Dr. S. P. Thompson. For polariser, he uses an Ahrens Prism, and for analyser a flat ended one of his own design. The Ahrens prism is formed from a rectangular block of spar, two faces of which are perpendicular to the optic axis; two cuts parallel to the axis are made from the middle of one side to the ends of the opposite, and the cut faces are polished and cemented by Canada Balsam. A short prism with wide angle is thus obtained which can be readily fitted to the sub-stage of the microscope. The analyser, which consists of two wedges of spar, is mounted in a tube which fits on the eye-piece, and by recognising that the upper end need not be larger than the pupil of the eye, the author has been able to considerably reduce the length of the prism, and still keep the bottom end large enough to collect all the rays passing through the eye-piece.

Several ingenious methods of cutting spar so as to produce prisms with minimum waste were described and illustrated by models, and a "Nicol" made by the inventor at the age of 79 was exhibited.

Mr. Lant Carpenter asked the exhibitor why he condemned analysers placed directly behind the objective; for in his experience this arrangement gave the most satisfactory results.

In reply, Dr. Thompson said his experience was decidedly different from that of Mr. Lant Carpenter, and mentioned that Ziess had abandoned the common arrangement and now introduced his analysers between the two lenses of his Huyghenian eye-pieces.

NOTICES OF BOOKS.

Townson and Mercer's Catalogue of Chemical and Physical Apparatus and Chemicals. Fourth Edition. London: 89, Bishopsgate Street Within, E.C.

The successive editions of this catalogue show considerable modifications in accordance with the increasing nicety and delicacy of modern research and the introduction of new instruments of precision. The edition before us includes appliances not merely for chemical and physical, but even for physiological research. Thus we note that apparatus for the cultivation and study of bacteria are figured and described at considerable length.

Appliances for the analysis of gases, whether for purely scientific or for technical purposes, form a very conspicuous and important feature. Of gas-burettes, absorption-apparatus, absorption- and explosion-pipettes, and complete sets for the examination of chimney, furnace, and chamber gases, the analyst now finds an ample selection from which he may choose the instruments best suited for his particular purpose.

Sets of apparatus to suit particular cases, or such as may be required by students at any part of their course, are strongly represented here. Thus, we find the set officially recommended for the analysis of beer, of wines, of tobacco; the sets prescribed for the Royal College of Chemistry, for the Cambridge and Oxford examinations, the set used by beginners in the laboratory of University College, the Frankland and the Wanklyn instruments for water-analysis, the Wanklyn set for medical officers of health, the apparatus for the study of physics and chemistry as recommended by the Science and Art Department, and other sets, too numerous to be mentioned.

The price list of chemicals is not so extensive as some which we have met with, and does not include certain rarities, both organic and inorganic, which the investigator may occasionally require. But the reagents now in use are all here to be met with, and in particular the new indicators used in alkalimetry and acidimetry. We regret to see magenta figuring under the name "fuschine."

The devices of Mr. Fletcher for the production of heat by the combustion of gas and petroleum figure in an appendix, as do the pure standard solutions of Messrs. Sutton.

Under the head "Telephone Apparatus" we note a curious fact. The United Telephone Company will neither themselves sell instruments to lecturers, students, &c., nor will they allow anyone else to do so, under the threat of an action for infringement. It is fortunate that novel scientific instruments, processes, &c., are not kept out of the hands of experimentalists in a similar manner.

Messrs. Townson and Mercer's Catalogue is something decidedly more than a mere price-list. It both tells the student what apparatus he will need for any proposed course in chemistry and physics, and gives the analyst and the investigator many useful hints concerning the instruments which they will require. We must therefore pronounce it a valuable book of reference, which deserves its place in the laboratory.

On Two New Indium Chlorides, and on the Vapour-densities of the Chlorides of Indium, Gallium, Iron, and Chromium. By L. F. Nilson and O. Pettersson. (A Reprint from the *Zeitschrift für Physikalische Chemie*, ii., 10.)

The authors show that indium possesses three chlorides, which are well characterised and permanent in the gaseous state. The trichloride, $InCl_3$, is not appreciably volatilised at 440°, and at temperatures between 606° and 850° it has a vapour-density agreeing with value 7·584, calculated for the formula $InCl_3$. Above 850° it undergoes a continuous dissociation, being probably split up into lower chlorides and free chlorine.

The dichloride, $InCl_2$, has, at 958°, a density rather higher than should follow from its formula, =6·362. At higher temperatures the density becomes normal. The monochloride has at 1100°—1150° a density 5·296, which approximates to the calculated density = 5·140. The complete series of the indium chlorides gives an interesting proof that an element of the third group can appear in definite compounds as monovalent, divalent, and trivalent.

The authors assign to the two gallium chlorides the formulæ $GaCl_3$ and $GaCl_2$. The calculated density of the former = 6·081, its experimental density at 606° being 6·144, and at 1000°—1100°, 5·185. The calculated density of the dichloride = 4·859, its experimental density at 1000°—1100° being 4·823. For ferrous chloride, $FeCl_2$, they find a density of 4·340 at 1300°—1400°, whilst calculation gives 4·375.

To the chromium chlorides they assign the formulæ $CrCl_3$ and $CrCl_2$. For the former the theoretical density is 5·478, the experimental results being 5·517 at 1191°. The theoretical density of the dichloride 4·256 falls below the experimental value, which, even at 1500°—1600° is still 6·224. This discrepancy the authors ascribe to the fact that chromous chloride cannot be perfectly gasified, even at the highest attainable temperature.

The Electricians' Directory and Handbook for 1889.—The 1889 Edition of this well-known Directory and Handbook is in preparation. The publisher, Mr. G. Tucker, 1, Salisbury Court, Fleet Street, London, E.C., asks us to notify that the time for receiving New Names, Addresses, Corrections, and Advertisements will shortly expire. The price of the Directory, which will be ready early in January, will be 4 shillings, post free.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 22, November 26, 1888.

New Experiments on the Determination of Nitrogen in Vegetable Soils.—MM. Berthelot and André.—The authors have instituted some novel experiments in order to ascertain what is the degree of accuracy in determinations of nitrogen in vegetable earth by skilled analysts operating at different intervals of time, and under different conditions, as well as the degree of stability of the nitrogen fixed in these soils, and submitted to different influences. They took, as terms of comparison, three distinct soils, preserved at the ordinary temperature in a place absolutely free from nitrogen, which renders any increase of this element in the soil impossible. To prevent any decrease in consequence of fermentations, oxygen was likewise excluded. The experimentalists took a soil in its natural condition, submitted it to spontaneous desiccation, and by grindings and siftings rendered it perfectly homogeneous. Half a kilo. of this powdered soil was placed in a large flask of 4 to 5 litres, filled with carbonic acid. It was agitated, let settle, and fresh carbonic acid was repeatedly introduced, until all the air in the soil was expelled. A 400 c.c. bottle was then taken, filled with pure CO_2, and the earth thus treated was introduced without contact with air. The bottle was closed with a ground stopper, smeared with vaseline. All these operations were performed in an atmosphere of pure carbonic acid, constantly renewed. After the lapse of four and a half months the soil was analysed, and was found not to have appreciably varied from its original composition.

Bulletin de la Société Chimique de Paris. Vol. l., Nos. 6 and 7.

Hydratation of Methyl-amyl-acetylene: A New Acetone, Ethyl-amyl-carbonyl.—A. Béhal.—The new compound has the formula $C_6H_{16}O$. It is insoluble in water, possesses a penetrating odour, and its density at 0° is 0·8502.

The Mineral Matter in Natural Petroleums.—J. A. Le Bel.—The black colouring-matter of bitumens and natural petroleums has received the name asphaltine. Some samples of this product contain iron, lime, and sulphur. Markownikow and Oglobine found, in the ash of the pretroleum of Baku, calcium, iron, alumina, copper, and traces of silver. Some samples contain as much as 10 per cent of sulphur. The author finds, in the ash of asphaltine, 13 per cent of silica, 17 iron oxide with traces of manganese, the rest consisting chiefly of lime and calcium sulphate. The interesting feature is the presence of silica, which cannot have been dissolved in the petroleum, and which affords an argument in favour of Mendeleeff's theory of the organic origin of mineral oils.

No. 8.

Action of Hydriodic Acid upon Allyl Iodide (continued).—H. Malbot.—The author's conclusions are that when a current of hydriodic acid is passed into allyl iodide there is first formed propylene iodide, an explosive body. If the current of hydriodic acid is too rapid the propylene iodide may suddenly decompose, even if surrounded by a freezing-mixture. If such sudden decomposition is partly or entirely prevented the propylene iodide may be partially or totally transformed into isopropyl iodide by the prolonged action of the hydriodic acid. There is no difficulty in admitting that the isopropyl iodide results from the combination of hydriodic acid with *nascent* propylene, derived from a limited decomposition of propylene iodide; but the gaseous propylene produced by a sudden splitting up escapes without combining, except in closed vessels. Propylene may be obtained in abundance by cautiously passing a current of hydriodic acid into allyl iodide, and occasionally applying a slight heat. The best precaution consists in diluting the explosive body with an inert liquid; for instance, isopropyl iodide.

Certain Crystalline Metallic Molybdates.—Antoine Coloriano.—The author describes the zinc, manganese, and cobalt molybdates, which he has obtained in the crystalline state. The corresponding salts of nickel, cadmium, and iron have been produced, but not yet analysed.

No. 9.

Researches on the Molecular Weights of the Aluminium Compounds.—M. Roux and E. Louise.—The results of the author's experiments, both the determinations of the vapour-densities and the depression of the freezing-points of the solutions, demonstrate that the organic compounds cannot in any case be determined by the simple formula AlX_3, but must have the double formula Al_2X_6.

The Volumetric Determination of Acids.—G. Linossier.—A question of priority. The author contends that his process described *Bulletin* (vol. l., pp. 46, 353, 354) is not identical with that of M. Engel (vol. xlv., p. 524).

An Alleged Reagent for the Copper Salts.—A. and P. Buisine.—M. Aliamet stated in a former number of the *Bulletin* that a saturated aqeous solution of neutral sodium sulphite, to which a little pyrogallic acid has been added, gives a rose-coloured solution in very dilute solutions of copper. The authors find that this reaction certainly takes place, but that it is not characteristic of copper, being producible with dilute aqueous solutions of most metallic salts, and even with distilled water.

A Process for the Determination and Separation of Zinc.—J. Riban.—Already noticed.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. Series 5, Vol. iii., No. 28.

Report by M. Biver on the Application of the Filtering Apparatus of M. Ladureau to Gas and Petroleum Motors.—This memoir cannot be intelligibly reproduced without the six accompanying figures.

MEETINGS FOR THE WEEK.

MONDAY, 17th.—Medical, 8.30.
— Society of Arts, 8. (Cantor Lectures). "Light and Colour," by Capt. W. de W. Abney, F.R.S.
TUESDAY, 18th.—Institute of Civil Engineers, 8.
— Pathological, 8.30.
WEDNESDAY, 19th.—Society of Arts, 8. "Standards of Light," by W. J. Dibdin, F.I.C., F.C.S.
— Meteorological, 7.
— Geological, 8.
THURSDAY, 20th.—Royal, 4.30.
— Chemical, 8.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Glycerin.—To what extent is sodium chloride soluble in glycerin.—T. H. S.

TO CORRESPONDENTS.

C. W.—Many experiments have been tried with the object of decomposing liquid carbonic acid, but no definite results have been arrived at.

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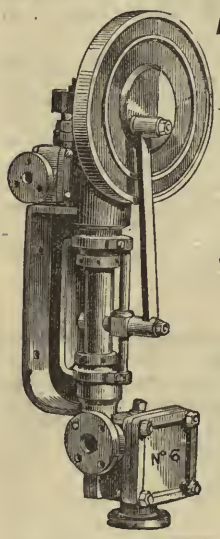

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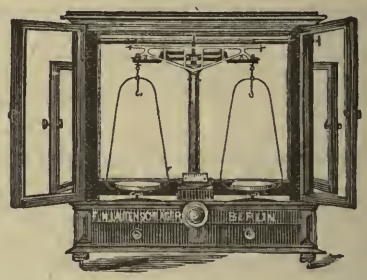

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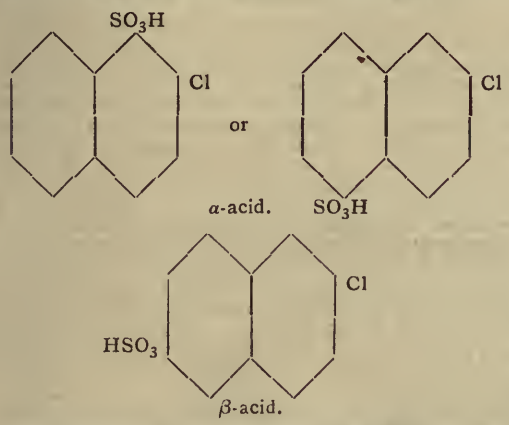
THE CHEMICAL NEWS.

VOL. LVIII. No. 1517.

ISOMERIC NAPHTHALENE DERIVATIVES.*

THE following is an outline of the work accomplished during the past year in the reporter's laboratory, chiefly with the invaluable co-operation of Mr. W. P. Wynne, B.Sc.

In discussing the laws of substitution for naphthalene, attention was directed in the first report to the *alpha-law* as the dominant law; and it was pointed out that whenever departures from this law occur, as a rule either the conditions are such as to favour secondary changes—as in the formation of β-sulphonic acids at high temperatures in presence of an excess of sulphuric acid—or a radicle such as OH or NH_2 is present which exercises a special influence. It was mentioned, however, in the same report, that when β-chloronaphthalene is sulphonated by means of SO_3HCl, two isomeric acids are formed, which there is reason to believe are represented by the formulæ:—



The conditions are such that the formation of the β-acid cannot be attributed to the occurrence of secondary changes, such as in all probability take place when sulphuric acid is the agent; the production of this derivative, therefore, cannot well be reconciled with the alpha law, but is suggestive of the existence in the naphthalene molecule of a "plane of symmetry" passing through the $\beta^2\beta^{3'}$-carbon atoms in which an influence is exercised. The observations on isomeric change, briefly described in the last report, prompted us, however, to determine whether the α-acid could not readily be converted into the β-acid by heating: the results entirely favour the view that the latter acid is in reality the product of isomeric change, and that its formation is in no way an exception to the alpha-law. When the sulphonation was effected in the cold, only three to four per cent of the product consisted of the β-acid; after heating the product at 100° for half an hour the amount rose to eleven per cent; heating at 150° for one hour increased the proportion of β-acid to twenty per cent; and no less than fifty-three per cent was present after heating at 150° for five hours.

These results have led us to study the behaviour of the chloronaphthalenesulphonic acids generally when heated, in order to determine whether, and in what way, they undergo isomeric change. In preparing the necessary material for these experiments we have converted the four isomeric modifications of betanaphthylaminesulphonic acid by Sandmeyer's method into the corresponding chloronaphthalenesulphonic acids, and by distilling these with phosphorus pentachloride, have prepared the corresponding dichloronaphthalenes. The designation of the amido-acid, the melting-point of the sulphochloride of the chloro-acid, and the designation and melting-point of the dichloronaphthalene are as follows:—

Betanaphthylamine-sulphonic acid.	Sulphochloride. m.p.	Dichloronaphthalene.	m.p.
(α) (Badische)	129°	(θ')	63·5°
(β) (Brönner).	109°	(ϵ)	135°
(γ) (Dahl)	70°	(η)	48°
(δ) (Bayer and Duisberg)..	86°	(δ)	114°

Isomeric Dichloronaphthalenes.—No less than 12 isomeric dichloronaphthalenes have now been described. The conventional plane symbol of naphthalenes serves to exhibit only ten, but a geometrical symbol may be constructed in accordance with the method followed by Herrmann in the case of benzene (*Berichte*, 1888, 1949) which foreshadows no less than sixteen. The following is a list of the reputed dichloronaphthalenes:—

(1)		m.p. = 34°
(2)	α	m.p. = 38°
(3)	η	m.p. = 48°
(4)	θ	m.p. = 61·5°
(5)	θ'	m.p. = 65°
(6)	β	m.p. = 68°
(7)	ζ	m.p. = 83°
(8)	κ	m.p. = 94°
(9)	γ	m.p. = 107°
(10)	δ	m.p. = 114°
(11)	ι	m.p. = 120°
(12)	ϵ	m.p. = 135°

α-α-Dichloronaphthalenes.—Nos. 6, 7, and 9 in the list belong to this category and represent the three possible α-α-derivatives: *β-dichloronaphthalene* is undoubtedly the α^1: α^4 *homonucleal* modification, being obtainable from naphthalene tetrachloride and from naphthionic acid; γ- and *ζ-dichloronaphthalenes* are heteronucleal compounds, and if no other evidence were forthcoming, the fact that the γ-compound has the higher melting-point would alone justify us in regarding it as the symmetrical α^1: $\alpha^{4'}$-derivative; since, however, it is obtainable from the nitrosulphonic acid isomeric with the α-α-acid known as the Schölkopf acid, which—taking Bamberger's researches into account—is a so-called *peri* or hetero-ortho-derivative, there cannot be any doubt that γ is 1 : 4' and that ζ is 1 : 1' dichloronaphthalene.

β-β-Dichloronaphthalenes.—Of the three possible β-β-modifications, δ- and *ϵ-dichloronaphthalene* are the two possible hetero-compounds; and from the high melting-point of the latter there can be practically no doubt that it is the symmetrical 2 : 3' modification, the δ-compound being therefore the 2 : 2' derivative.

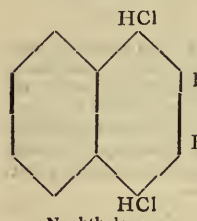
α-β-Dichloronaphthalenes.—Four are possible, two hetero and two homonucleal. η- and θ'- (m.p. 63·5°) *dichloronaphthalenes* may be prepared, as above stated, from Dahl's and the Badische modification of *beta*naphthylaminesulphonic acid respectively, and also from two α-nitro-acids obtained by Cleve by nitrating naphthalene-*beta*sulphonic acid; they are therefore undoubtedly α-β-compounds, and are probably both heteronucleal. If these arguments be correct, the one is 1 : 2', the other 1 : 3' dichloronaphthalene.

θ-Dichloronaphthalene (m.p. 61·5°) is either the 1 : 2 or the 1 : 3 modification. *α-Dichloronaphthalene*, the product of the action of alkali on naphthalene tetrachloride, is undoubtedly a homonucleal compound. The modification melting at 34°, prepared by Cleve from chlorobetanaphthol and chlorobetanaphthylamine, is also homonucleal;

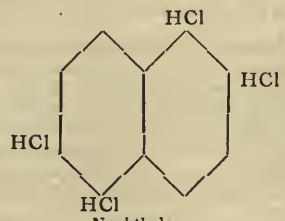
* Third Report of the Committee, consisting of Professors Tilden and Armstrong (Secretary), appointed for the purpose of investigating Isomeric Naphthalene Derivatives. (Drawn up by Professor Armstrong). Read at the British Association, Bath Meeting, 1888.

this latter is an *alpha*chloronaphthalene derivative (Cleve), so that the dichloronaphthalene melting at 34°, if not the 1 : 2 is the 1 : 3 variety. By exclusion, it would follow that α-dichloronaphthalene is the third β-β-, *i.e.*, β^2-β^3-dichloronaphthalene.

κ- and ι-dichloronaphthalenes have thus far been omitted from consideration; the former is probably non-existent, the method by which it is said to have been prepared being one which is very unlikely to afford a dichloronaphthalene. It is not improbable that the ι-compound will also be found non-existent; if on treating naphthalene with chlorine a small quantity of an isomeric heteronucleal tetrachloride be formed, and this lose its α-chlorine atoms, ε-dichloronaphthalene would result, and it is possible that this substance in an impure state may have been regarded by mistake as a distinct substance.



Naphthalene homotetrachloride.



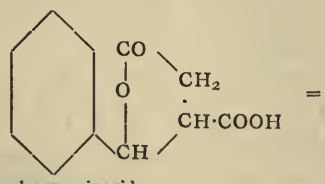
Naphthalene heterotetrachloride.

ε-dichloronaphthalene.

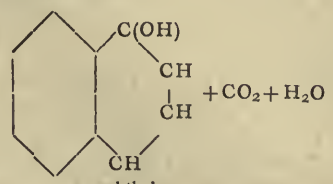
Isomeric Dichloronaphthalenesulphonic Acids.—With the object of further characterising and determining the individuality of the dichloronaphthalenes, the study of their sulphonic acids, to which reference was made in the last report, has now been extended to all. The chief result of interest is the fact that the dichloronaphthalene melting at 34° yields certainly two, perhaps three, isomeric sulphonic acids; the sulphochloride of the one acid crystallises in minute prisms melting at 168°, that of the other in massive prisms melting at 105°.

The dichloro-acids prepared by Widman by chlorinating naphthalene-α- and β-sulphochlorides have also been examined. That from the β-sulphochloride yields when hydrolysed β-, that from the alpha-sulphochloride what appears to be θ-dichloronaphthalene, m.p. 61·5°.

Addendum.—Since the meeting of the Association, Erdmann and Kirchhoff (*Annalen*, 247, 366) have described the results of experiments on the synthetic production of



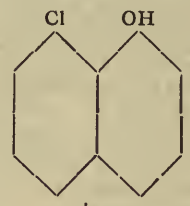
Phenylparaconic acid.



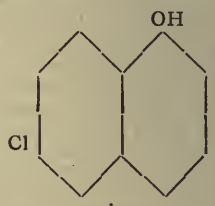
α-naphthol.

chloronaphthalene derivatives which they contend afford proof of the constitution of the γ, η, and θ varieties of dichloronaphthalene. Their method consists in preparing chlorophenylparaconic acids by interaction of succinic acid and chlorobenzaldehydes; by distilling the acids chloronaphthols are obtained, from which corresponding dichloronaphthalenes are prepared by distillation with phosphorus pentachloride. The conversion of phenylparaconic acid itself into alpha-naphthol is supposed by Fittig and Erdmann to take place in the manner indicated by the accompanying symbols. (See preceding column).

Assuming that the chloro-acids undergo a similar change, the acids derived from ortho- and parachlorobenzaldehyde should each yield but a single chloronaphthol, and that from the metachlor-aldehyde should alone be capable of yielding two isomers, viz.:—



1′ : 1



3′ : 1

Actually they obtained eventually from the metachloro-acid η-dichloronaphthalene (m.p. 48°); and as ζ-dichloronaphthalene (m.p. 83°) is undoubtedly the 1 : 1′ derivative they regard the η as the 1 : 3′ derivative. The ortho-chloro-acid was found to yield γ-dichloronaphthalene, and hence they regard this as the 1 : 4′ derivative—a conclusion which harmonises with previous views. θ-dichloronaphthalene (m.p. 61·5°) was prepared from the para-chloro-acid, and accordingly this is represented to be the 1 : 2′ derivative.

But these conclusions are entirely based on the assumption that the naphthol-hydroxyl is derived from one of the carboxyl groups of the succinic acid, as indicated by the symbols given above; there is, however, no reason why it should not be derived from the COH group of the aldehyde, and in this case the η would be the 1 : 2′ and the θ the 1 : 3′ derivative. In any case this objection entirely deprives Erdmann and Kirchhoff's arguments of their force: as in the case of benzene, there is little doubt that the constitution of naphthalene derivatives will be determined eventually by the study of naphthalene derivatives and not by synthetic methods of the character of those in question.

ON THE RAPID AND SURE DETECTION OF ANTIMONY IN MINERALS.

By ALEXANDER JOHNSTONE, F.G.S.,
Assistant to the Professor of Geology and Mineralogy in Edinburgh University.

Minerals which contain antimony, when heated *alone* before the blowpipe on charcoal, or with the *addition* of three or four parts of fusion mixture ($K_2CO_3+Na_2CO_3$), yield dense white fumes of antimonious oxide,* which in great measure escape into the atmosphere, but which also in part become deposited on the charcoal support, forming a well-marked white sublimate, coat, or incrustation of the oxide.

Those results, though certainly in most cases very useful indications, do not furnish to the satisfaction of the mineralogist sound, conclusive evidence of the presence of antimony in the mineral tested, seeing that several other

* Not altogether *antimonious* oxide (Sb_2O_3) according to Dittmar That chemical authority asserts that a small portion of the coat is composed of the amorphous antimony tetroxide (Sb_2O_4).

bodies occurring in the mineral world give, when heated before the blowpipe, exactly the same or nearly similar reactions. As a consequence of the hitherto inconclusive blowpipe evidence, mineralogists have usually considered it essential when engaged in correct work to supplement those indications by means of the accurate but tedious method of the ordinary wet way qualitative chemical analysis.

With a view to remove the necessity of consuming so much valuable time over the certain identification of antimony the author wishes to bring under the notice of mineralogists the following exceedingly simple but thoroughly trustworthy test, which he discovered and successfully applied whilst working amongst the various metallic ores of antimony.

To the white coat which will invariably form on the charcoal if the mineral containing antimony be properly treated and heated before the blowpipe add, by means of a narrow glass tube, a single drop of ammonium sulphide. If the white sublimate is composed of antimonious oxide, then the portion touched by the drop (or the part touched by the *edge* of the drop) will immediately become converted into the well known and highly characteristic *reddish or orange* sulphide of antimony.

As no other white coat producible on charcoal by heating a mineral in the blowpipe flame becomes *reddish* or distinctly *orange* in colour when treated as above with ammonium sulphide, the value of this easily applied test must at once be apparent.

LIEBREICH'S DEAD SPACE IN CHEMICAL REACTIONS.

By GEORGE WATSON, F.C.S.

In the December part of the *Journal of the Chemical Society* occurs an abstract account of Liebreich's experiments on the dead space in chemical reactions, or the space exempt from any chemical change taking place in a liquid, and as no explanation of the phenomena is there given, I venture to suggest what appears to me a probable one, to wit, that the phenomena in question are solely caused by the surface energy of the glass vessels in which the liquids are contained.

From Liebreich's experiments the following conclusions are drawn:—1st. No chemical change is initiated in the layer of liquid immediately below the meniscus. 2nd. The rate of chemical change varies as the diameter of the vessel in which the liquid is contained, being slower the smaller the diameter, and *vice versa*. 3rd. In capillary tubes no chemical change whatever is engendered.

These results may all be caused by the surface energy of the glass. For, take any glass dish, say, for the sake of clearness, a test-tube, and consider how its internal surface energy will influence a liquid placed in it. The glass exerts an attractive force on the liquid immediately contiguous to it, tending, as it were, to densify the liquid. A stress is thus set up, radiating to the internal circumference of the test-tube from a vertical line cutting the axis of the cylinder of liquid. This produces a downward vertical stress, giving rise to a concave meniscus, and increasing the surface-tension of the liquid. The distribution of force or of strain in the layer of liquid just below the meniscus must be different, therefore, from that deeper down, and any chemical change taking place in the liquid may thus be influenced. If the effect be a retarding one in the case of a concave meniscus, then, if the liquid were placed in a tube whose walls gave a repellent effect instead of an attractive one (forming a convex meniscus), we should expect the influence to be now an accelerating one. The dead space should be transformed into one of greater vitality than the rest of the liquid

In the same way may be explained the fact that no chemical change was found to take place when the liquids were contained in capillary glass tubes. For, imagine the liquid to be contained in a square glass dish having one side capable of being moved inwards to any required closeness to the opposite side, and that a suitable chemical change is about to begin in the liquid. Then, by sliding in the movable side, one of the diameters of the dish is being continually decreased, and the starting of the chemical change will be simultaneously continually postponed, until, when the two sides have come so close together that a capillary plane has resulted, the postponement has become infinitely long, *i.e.*, the chemical change never begins. Similar considerations also show why variations in the diameter of the test-tubes give corresponding variations in the rates of the change.

It might be surmised, therefore, that if a vessel were filled completely and in such a way that no meniscus was formed, then no differentiation in the rate of the change should result, and this is confirmed by Liebreich's own experiments; the case in which a full test-tube closed by a piece of parchment gave a dead space being probably due to osmotic stress set up by the parchment in its vicinity.

And this explanation does not seem so improbable when we consider the many cases in which the local increase of surface energy produced by scratching the sides of the containing vessel hastens the formation of precipitates in those cases in which a precipitating stress exists. A good illustration of this is seen in the following experiment:—If some antimonious chloride be dissolved in a saturated solution of sodic chloride, a liquid is obtained which is quite clear at first, but which, being in a state of instability, deposits, on standing, a portion of its antimony as basic salt. If scratches be made on the glass, however, in the newly prepared liquid, such scratches are in a very short time—indeed almost at once—coated by a deposit of basic salt, the liquid otherwise remaining clear. This result is due to the slight increase of surface energy produced locally by the scratching, and inasmuch as a certain quantity of muscular energy is expended in producing an abrasion, causing the disappearance of its equivalent of cohesive force, and the appearance of the same amount of surface energy, it is evident that the surface energy of all solids is dependent on their intrinsic cohesive force; for any mass of solid may be viewed as having been originally part of a larger mass, and as having been formed from it by breaking or sub-division. Increase of surface is the inevitable concomitant of comminution, and comminution is the disappearance of so much cohesive force.

THE ACTION OF AMMONIA ON METALLIC MAGNESIUM.

By H. N. WARREN, Research Analyst.

Magnesium, heated in a current of dry ammonia, provided the temperature be kept below redness, apparently undergoes no change, but, on examining the same at the termination of the reaction, a marked distinction is observable as regards its chemical properties, refusing to melt below a red heat, and burning, when ignited, with most violent decrepitations. If, while in this form, it be still further heated, the temperature being raised to full redness, the current of gas being still maintained, the whole is gradually converted into an orange-yellow powder, unalterable at all normal temperatures, and producing evidence of the formation of ammonia after the addition of sodium hydrate to an acidified solution of the same. It also not unfrequently happens, on dislodging the coils of magnesium that have been sustained at a dull red heat only, when under the influence of the ammonia gas, that small quantities of the ribbon thus employed have assumed a deep yellow colour, and of a lustre equal to that of gold. This peculiar substance, whether indicative

of an allotropic modification, or the formation of a nitride, is as yet impossible to state, owing chiefly to the uncertainty of producing the same. From several observations, however, I am of opinion that traces of aqueous vapour tend to favour its formation.

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NEW METHOD OF DETERMINING CARBONIC ACID IN SOLUTION.

By LEO VIGNON.

Carbonic acid in an aqueous solution, whether free or combined with the neutral carbonates, rapidly decolourises the red liquid formed by mixing 50 c.c. of lime-water and 10 drops of a saturated alcoholic solution of pure phenolphthalein. Hence it results that carbonic acid dissolved in water, free or in a state of semi-combination, can be determined volumetrically by means of a standard solution of calcium hydroxide, using, under suitable conditions, phenolphthalein as an indicator.

The details of the process are as follows:—50 c.c. of the water in which the carbonic acid is to be determined are mixed with 0·05 c.c. (10 drops) of a saturated alcoholic solution of phenolphthalein, and there is gradually added to the liquid lime-water which has been previously standardised (by means of decinormal sulphuric acid and cochineal) until it takes and retains the rose shade which is characteristic of phenolphthalein in presence of an excess of lime. In order to obtain constant results, it is necessary to compare the final tint with that of a liquid of the same composition as the water to be examined, but perfectly free from carbonic acid. As a type there may be used either water recently distilled, or a portion of the water under examination, which has been boiled long enough to expel all carbonic acid.

Fifty c.c. of each of these two liquids, raised to the same temperature, are placed in two test-glasses on feet, graduated, having ground glass stoppers, and not exceeding 2 or 3 c.m. in diameter. Into each glass are put 10 drops of the alcoholic solution of phenolphthalein, and we then begin to colour slightly the type liquid with a measured quantity of standardised lime-water added from a burette graduated in tenths of a c.c. without reaching the maximum colouration which can be produced. 0·2 to 0·5 c.c. will mostly suffice.

The solution of lime is then gradually added to the water under examination. The colour produced by the contact of the lime-water disappears very rapidly on agitation at the beginning, so long as carbonic acid is found in the liquid in sufficient excess. Towards the end of the reaction the combination of the lime with the carbonic acid takes place more slowly; it is therefore convenient to agitate the liquid frequently and to add the lime-water at longer intervals. Care must be taken not to let the colour in the water in question exceed the intensity of colour of the type. When the colouration of the sample no longer varies, which occurs after an hour, if the precaution has been taken to agitate frequently, the type is made up to the same volume as the water to be examined, and an identity of shade between them is effected by adding lime-water to that which is palest.

The two glasses are used like the tubes of a colorimeter. On examining them against a white ground we may, with a little practice, detect the shades of colour due to the addition of 0·1 c.c. of lime-water. When the colours are identical we know that the two liquids contain the same quantities of free lime. The difference between the lime consumed by the water under examination and that which has served to colour the type corresponds to the carbonic acid sought for.

The presence of calcium and magnesium chlorides, sulphates, and nitrates does not affect the results. Calcium carbonate, indeed, colours phenolphthalein slightly, but, besides that this colouration is not comparable in intensity to that yielded by free lime, it is not manifested in presence of carbonic acid.

If the water contains alkaline salts, the acids of which are capable of forming insoluble salts of calcium or magnesium carbonate, which is slightly alkaline before titration, a little neutral calcium chloride must be added to convert the magnesium carbonate and the alkaline salts into chlorides. This peculiarity may be detected by the colour which the water, after being boiled in a platinum capsule, will take with phenolphthalein.

If the water contains much carbonic acid the calcium carbonate renders the liquid opaque, and does not permit of a colorimetric comparison with the type. This inconvenience may be remedied by adding to the coloured type a little pure calcium carbonate, or by letting the calcium carbonate in the sample under examination have time to settle.—*Bulletin de la Soc. Chimique de Paris* (vol. xlix., p. 903).

PROCEEDINGS OF SOCIETIES.

THE ROYAL SOCIETY.

Anniversary Meeting, November 30th, 1888.

Address of the President, Prof. G. G. Stokes.

In the month which intervened between our last anniversary and the end of the year, the Society lost four of its Fellows. In addressing the Fellows last year, I referred to the loss which science had sustained through the death of the illustrious Kirchhoff, and before three weeks were out, one followed him to the grave whose researches on the connection between the emission and absorption of radiant heat and light were closely akin to those of Kirchhoff. I refer to Balfour Stewart, who, shortly after landing in Ireland, whither he had gone to spend the Christmas with his family, was suddenly carried off after only a few hours' illness, shortly after he had entered on his sixtieth year. His name is widely known on account of his scientific work in heat, magnetism, and solar physics. He has been a member of the Council, and the Rumford Medal of the Society was awarded to him for the particular research to which I alluded at the outset. The other three of our ordinary Fellows who died before the month was out were all far advanced in years. Two of them were eminent in the medical world, Sir George Burrows and Dr. Arthur Farre, both of whom served on our Council. Early in the year we lost one of our Fellows, who, while not a man of science, was eminent in literature and jurisprudence. While our ranks are mainly recruited from men of science, we gladly welcome among us men who, like Sir Henry Sumner Maine, have proved their ability and earned their distinction in other branches of knowledge; whose connection with us we look on as honourable to the Society, while, as the very fact of their joining us shows, they regard the Fellowship as honourable to themselves. Admiral Sir Cooper Key, who was highly distinguished as a naval officer, and was at one time Director of the Royal Naval College at Greenwich, was another who served on the Council. Philip Henry Gosse, who died at an advanced age, is well known for his charming popular works on natural history. These are some of the Fellows on the home list who died since the last anniversary; but besides these we have lost no less than three of our foreign members. Prof. Anton de Bary, so well known for his researches on the Cryptogams, and the eminent naturalist, Prof. Asa Gray, who not very long ago was over in this country, both died in January. Comparatively recently we have lost Prof. Clausius, so eminent as a physicist, especially in the department of thermodynamics.

The year of the Society which terminates to-day has shown no flagging in scientific activity. Since the last anniversary thirty-three memoirs have been published in the *Philosophical Transactions*, containing a total of 1010 pages and 91 plates. Of the *Proceedings*, 19 numbers have been issued, containing 1008 pages and 17 plates. In addition to this, a monograph of the "Horny Sponges of Australia," by Dr. R. von Lendenfeld, which was accepted for publication by the Council, and which when completed will extend to about 1000 pages, is now nearly through the press.

A large amount of work connected with the Library has been done since the last anniversary. A special effort has been made to complete imperfect series of scientific periodicals; and by means of exchange, or by the generosity of our corresponding societies, some hundreds of deficient numbers have been obtained. The lists of Institutions entitled to receive gratis the *Philosophical Transactions* and *Proceedings* have also been carefully revised by the Library Committee.

In December last Mr. Arthur Soper was engaged as a special Assistant to continue the formation of the Shelf-Catalogue, and the revision of the Catalogue of MSS., and other work. The Shelf-Catalogue of the Upper Library is now completed—a work involving the re-arrangement or removal to the lower stories of several thousands of volumes. Considerable progress has been made in collating and cataloguing the Archives and other manuscripts belonging to the Society, and an instalment of slips have been written towards a Catalogue of the Miscellaneous Literature in the Library.

In the course of this work many duplicate scientific books, and literary works of little value to the Society, have been thrown out, and these have been presented by order of the Council to the libraries of the Universities and some of the chief scientific Societies.

The cataloguing of the titles of scientific papers for the decade 1874 to 1883 is now complete, and the work is ready for the press. The amount of matter is estimated to require, if printed, three quarto volumes of the usual size. The extraction of the title, the preparation of the work for the press, and the correction of the proofs of this work, which is really of international importance, has all along been done at the sole charge of the Royal Society; but the printing of the volumes which have already been published has been done at the Stationery Office by the authority of the Lords of the Treasury, and the proceeds of the sale have been paid in to the Treasury. The Council have applied to the Lords Commissioners of Her Majesty's Treasury to sanction the printing of the last decade in a similar manner, and it is hoped that the application may be favourably entertained.

In the year 1882 a change was made in the amount and mode of administration of the grant which for a considerable time before had been voted annually by Parliament for scientific research. Since that year the annual grant has been one of £4000, which has been administered by the former Government Grant Committee, with the addition of certain *ex-officio* members, mostly the Presidents of certain scientific Societies. Meetings of this large Committee, consisting usually of about fifty members, have been held twice a year, and the various applications for aid from the grant to enable the applicant to carry out investigations explained by him, have been previously discussed in meetings of three, or latterly two, Sub-Committees, into which the whole Committee was divided, and then submitted to the General Committee for confirmation or modification.

In the discussion of these grants, the Government received the benefit of the gratuitous services of a large number of men of the highest distinction in science. In the large Sub-Committees, however, it necessarily happened that of the members present only a fraction would be likely to be conversant with the particular branch of science to which any particular application belonged; and the Council thought that the time of the members might be economised, and at the same time a more efficient discussion of the grants secured, by arranging the applications under a number of sub-divisions, and assigning the discussion of these to a corresponding number of Boards formed out of the General Committee. It was thought that a good deal of the discussion of the applications in the several branches might be carried on by correspondence among the members of the respective Boards, so that one or two meetings of each Board might suffice. If some trouble were thus saved to the members of the Committee in regard to personal attendance at long meetings, there would probably be more expenditure of time in the way of correspondence, and it was thought that one meeting of the General Committee in the year would in most cases suffice. To meet pressing cases in the interval, it was suggested that a limited sum might be placed by the General Committee at the disposal of the Council of the Royal Society. There are further provisions for forming a reserve fund of not more than £2000 to meet special objects involving unusual expenditure, and for holding in reserve out of the money available for any one year enough to meet annual grants of limited amount made for a period not exceeding three years, the future grants being contingent on the receipt by the Committee of satisfactory evidence of progress in the inquiry. The new regulations, of which I have merely given a slight sketch, have been communicated to the Treasury, and will come into operation next year.

The Krakatao Committee have now completed their work, and the volume which is the outcome of their labours is in the hands of the public. The society is much indebted to those Fellows and other gentlemen who discussed and reported on the different subjects into which the whole inquiry was divided, and to Mr. Symons, who was the first to propose that the materials should be collected, and to whose unwearied labour as Chairman of the Committee, director of the correspondence, and editor of the volume, the successful accomplishment of the undertaking is largely due. The work has been favourably noticed in more than one quarter. A comprehensive and digested account of that extraordinary volcanic explosion, remarkable both for its magnitude and the striking disturbances and other phenomena attending or following it, is now placed within easy reach of the ordinary reader, and will go down to posterity; whereas, had the various accounts remained in their isolated form, they would many of them have perished, and the remainder could not have been brought together without a most laborious search. It must be a great satisfaction to my predecessor in this chair to remember that he urged upon the Council the importance of collecting the facts before the materials should have become dissipated, and while the freshness of men's recollection of the event kept up a lively interest in all that belonged to it.

The Royal Society is in possession of some important standards for the safe keeping of which we are responsible. Parliamentary copies of the standard yard and standard pound have been intrusted to our custody; and we have also a standard measure of length known as Sir George Schuckburg's scale, with reference to which the length of the seconds pendulum for Greenwich has been determined by Kater and Sabine. This length, as determined by experiment, has been defined with reference to the interval from the 0 to the 39- and 40-inch graduations on the scale; but no exact comparison has hitherto been made between the length of this portion of the scale and the national yard, and such a comparison is no easy matter. It happens that Commandant Deforges has been engaged in determining the length of the seconds pendulum at Greenwich with reference to the French standard metre, and just before his return to Paris he came to our meeting and offered to take charge of the scale, bring it with him to Paris, and there determine the length of the part of the scale used by Kater and Sabine with reference to the metre, for doing which he has all the requisite appliances; and as we know the ratio of the metre to the yard, the

length of the seconds pendulum, as determined by Kater and Sabine, would thus be known accurately with reference to the standard yard. It seemed to me that so important a scale should hardly be sent away, even though in the care of so experienced a physicist, without the authority of the Council, and without an outer case being made for its box, which there was no time to get ready. The authority of the Council has since been obtained, and it fortunately happens that one of the assistants at the Greenwich Observatory is going to Paris who will take change of the scale. Thus by the kind proposal of Commandant Deforges we may shortly hope to have an authentic comparison of the length of the seconds pendulum as measured by Kater and Sabine with the standard English yard.

At the time of the anniversary last year, some of the reports of the observers who went to Grenada to observe the total solar eclipse of August, 1886, had been sent in, and I mentioned that it seemed desirable, for convenience of reference at a future time, that the different reports should come out together, instead of being published in a scattered form, provided at least that the waiting for the later reports should not cause too much delay. I regret to say that the completion of the reports has been delayed in part by the illness of one of the observers, but I have every hope that they will all be in by Christmas, and I do not anticipate that any long time will elapse before they will be in some form in the hands of the public.

The time is well within our recollection when the occurrence of the solar prominences seen in total eclipses first attracted the attention of astronomers, and when for observations bearing on ther nature we had to wait for the rare and brief glimpses which, clouds permitting, were afforded by total eclipses. Now, however, thanks to the method of observation devised independently by Lockyer and Janssen, they may be studied at any time. It would obviously be a great advantage if a similar study could be made of the corona; for though we cannot expect to obtain a picture of it equal to that which may be got during a total eclipse, yet, if a fairly good picture could be obtained from time to time, we might thereby be enabled to learn more about the history of its changes than could be got by observations extending over a lifetime if restricted to total eclipses. Some observations were made during the partial phases of the last total eclipse with the view of throwing light on the prospect of success. Notwithstanding the unpromising nature of the results obtained, I have reason for hoping that the desired object may yet be accomplished.

In addressing you last year, that year which will be memorable as the Jubilee of the reign of our beloved Sovereign, I alluded briefly to the progress which science had made in the last half-century, and ventured to indicate one or two directions in which it seemed to me possible that a very great addition to our physical knowledge might some day be reached. I will not to-day venture to look so far ahead; but the mention of a total eclipse leads me to refer to some theories now before the scientific world which are likely to undergo full discussion and further examination in the near future, with the probable result of a pretty general agreement as to their acceptance or rejection.

It is now many years since Dr. Huggins discovered the peculiar character of the spectra of the nebulæ, spectra which he found to consist mainly of bright lines, indicating that what we see is an incandescent gas. The natural supposition to make at the time was that those distant masses of matter consisted of incandescent gas, of which the luminosity was in some way kept up, probably as a result of condensation. But the researches of Mr. Lockyer, as described by him in the Bakerian Lecture which he delivered last spring, and in part in a previous paper communicated shortly before the last anniversary, have led him to take a different view of the constitution of nebulæ. According to the theory advanced by him, the mass of a nebula consists mainly of meteorites, which are constantly coming into collision here and there; and the glowing gas the existence of which the spectroscope reveals, is merely a portion of the matter, volatilised by the heat of collision. According to the former view, therefore, the nebula consists of glowing gas, not yet condensed into a solid or liquid form, possibly in a condition even more elementary than that of the so-called elements that we know on earth; according to the latter it consists mainly of discrete portions of solid matter, and the glowing gas does not consist of the same matter permanently glowing, but is continually supplied afresh by fresh collisions.

A similar theory is applied to explain the self-luminosity of the nucleus, and sometimes the very root of the tail, of comets. A comet is regarded as a swarm of meteorites, moving in orbits not greatly differing from one another; and as the swarm approaches the sun collisions become more frequent, and individually more potent, from an increase in the velocities, differential as well as absolute; and a portion of matter is volatilised and rendered incandescent. As to the tail, the theory long ago suggested by Sir John Herschel has always seemed to me by far the most probable of those that have been advanced—namely, that it is due to the propulsion of excessively attenuated matter, owing to a repulsive force, probably of electrical origin, emanating from the sun. This view seems to be adopted both by Mr. Lockyer and Dr. Huggins; and the latter gentleman, in an earlier Bakerian Lecture, has suggested a new theory of the corona—the corona as distinguished from the prominences—namely, that it is not projected from the sun by molar farces due to the tremendous state of turmoil in which we have very strong reason for believing that the matter composing the sun exists, but of matter actually propelled from the sun by a repulsive force in the manner of the tails of comets.

Daring as some of these speculations may appear to be, there seems a great deal to recommend them, and the whole subject is one of extreme interest at the present day.

But I must not take up your time longer by dwelling on so special a subject; I proceed to matters more particularly connected with the occasion on which we are assembled.

The Council have awarded the Copley Medal of the year to my predecessor in this Chair, Mr. Huxley, for his investigations on the morphology and histology of vertebrate and invertebrate animals, and for his services to biological science in general, during many past years. These subjects lie so entirely out of the range of my own studies that I need hardly say that in attempting to give some idea of the more salient features of his investigations I am dependent upon the kindness of biological friends.

During the fifteen or twenty years which preceded the publication of Darwin's famous work, the "Origin of Species," the views and methods of comparative anatomists underwent a most marked change. Without the change, biologists would have been far less prepared to accept Mr. Darwin's work, and, what is even more important, would have been unprepared to make use of that work as a light enabling them to carry on the remarkable researches which have so brilliantly characterised the progress of biology during the last quarter of a century. That change was effected chiefly by the labours first of Johannes Müller, and subsequently of Huxley in this country, and of Gegenbaur in Germany. The labours of these men opened out the right road of morphological inquiry. It is not, perhaps, too much to say that Mr. Huxley's treatment of his subject in his "Morphology of Cephalous Mollusca" was to many young morphologists little short of a revelation, and all his other works of the same period, such as that on the Hydrozoa and on Tunicates, and, later still, his treatment of the Vertebrate skull and skeleton, and Arthropoda, produced in varying degree a like effect.

Closely allied to, or rather forming part of, his morphological labours, are his numerous palæontological re-

searches, carried out for the most part while he was Palæontologist to the Geological Survey, researches characterised by the same clear morphological insight, researches which have been as profitable to animal morphology as useful to the geologist. The most important are perhaps those on the remarkable reptiles of the Elgin Sandstones and on the Dinosauria; but many others have great value, and his anniversary address to the Geological Society, in 1870, made its mark.

Though his career has been in the main that of a morphologist, he has through the common ground of histology given considerable help to physiology. An early paper by him "On the Cell-Theory," did much to clear away erroneous notions concerning the relations of structure to the actions of living beings. His article on "Tegumentary Organs" was a great step onward as regards both morphology and histology, and still remains a classical work; while, by other papers and in various ways, he has contributed to the progress of histology and physiology.

But, however important Mr. Huxley's original contributions to the advancement of our scientific knowledge have been, we should form a very inadequate idea of his benefits to the cause of science if we did not bear in mind also his singular ability and effectiveness as an expositor of science to the people, and the powerful influence he has exerted in the improvement of the teaching of biology in its widest sense in this country. Indeed, it is not too much to say that the remarkable improvement which has taken place within the last few years must be ascribed either directly or indirectly to his influence, and has been in many cases due to his initiation.

The Rumford Medal has been awarded to Prof. Pietro Tacchini for important and long-continued investigations, which have largely advanced our knowledge of the physics of the sun.

Prof. Tacchini occupies a foremost place among those who have paid special attention to to the physics of the sun. Since 1870 he has unceasingly observed, first at Palermo, and afterwards at Rome, the solar prominences. The information at our disposal at the present time, both as regards their distribution, their spectra, and the changes which take place in them, and their connection with other solar phenomena, rests to a large extent upon his individual efforts. His memoirs on this subject are very numerous. He has been engaged in the observation of four total solar eclipses, and from some of the phenomena therein observed has drawn the important conclusion that many of the so-called prominences are really descending currents.

A Royal Medal has been awarded to Sir Ferdinand von Mueller for his long services in Australian exploration, and for his investigations of the flora of the Australian continent.

For more than forty years von Mueller has been working, without intermission, at scientific botany and its practical illustrations. As a botanical traveller and collector, he has, to quote the words of Sir Joseph Hooker, "personally explored more of the Australian continent than any other botanist, except Allan Cunningham." No one has investigated the Australian flora and the geographical distribution of its components with so much perseverance and success, and no one has enriched our herbaria, laboratories, and gardens with materials for study to so great an extent. The eleven volumes of the "Fragmenta Phytographiæ Australiæ" contain the descriptions of a great series of new plants, and the unrestricted communication of his collections and observations to the late Mr. Bentham rendered possible the preparation of the "Flora Australiensis," in seven volumes, the only account of the vegetation of any large continental area which has at present been completed.

He has especially devoted himself to the elucidation of the most difficult though most characteristic groups of the Australian flora; and as a result of his labours in this direction, his "Eucalypto graphia" may be more particularly mentioned, a work which will always be the standard of nomenclature for the intricate genus *Eucalyptus*. Of a similar character are his descriptions and illustrations of the "Myoporineous Plants of Australia," and his Iconography of the Genus *Acacia*." To him is also due the foundation of the Government Herbarium at Melbourne, the first great botanical collection formed in the southern hemisphere, and the future centre of all scientific work on the Australasian flora.

A Royal Medal has been awarded to Prof. Osborne Reynolds for his investigations in mathematical and experimental physics, and on the application of scientific theory to engineering.

Prof. Reynolds was among the first to refer the repulsion exhibited in that remarkable instrument of Mr. Crookes's, the radiometer, to a change in the molecular impact of the rarefied gas consequent upon the slight change of temperature of the movable body due to the radiation incident upon it; and in an important paper published in the *Philosophical Transactions* for 1879, he deduced from theoretical considerations the conclusion that similar phenomena might be expected to be observed in bodies surrounded by a gas of comparatively large density, provided that surfaces were very small. He verified this anticipation by producing on silk fibres, surrounded by hydrogen at the atmospheric pressure, impulsions similar to those which in a high vacuum affect the relatively large discs of the radiometer.

In an important paper published in the *Philosophical Transactions* for 1883, he has given an account of an investigation, both theoretical and experimental, of the circumstances which determine whether the motion of water shall be direct or sinuous, or, in other words, regular and stable, or else eddying and unstable. The dimensions of the terms in the equations of motion of a fluid when viscosity is taken into account involve, as had been pointed out, the conditions of dynamical similarity in geometrically similar systems in which the motion is regular; but when the motion becomes eddying it seemed no longer to be amenable to mathematical treatment. But Prof. Reynolds has shown that the same conditions of similarity hold good, as to the average effect, even when the motion is of the eddying kind; and moreover that if in one system the motion is on the border between steady and eddying, in another system it will also be on the border, provided the system satisfies the above conditions of dynamical as well as geometrical similarity. This is a matter of great practical importance, because the resistance to the flow of water in channels and conduits usually depends mainly on the formation of eddies; and though we cannot determine mathematically the actual resistance, yet the application of the above proposition leads to a formula for the flow, in which there is a most material reduction in the number of constants for the determination of which we are obliged to have recourse to experiment.

There are various other investigations of Prof. Reynolds's which time would not allow me to enter into, and I therefore merely mention his investigation of the relation between rolling friction and the distortion produced by the rolling body on the surface on which it rests, that of the effect of the change of temperature with height above the surface of the ground on the audibility of sounds, and his explanation of the effect of lubrication as depending on the viscosity of the lubricant.

The Davy Medal has been awarded to Mr. Crookes for his investigations on the behaviour of substances under the influence of the electric discharge in a high vacuum.

Mr. Crookes's remarkable series of researches which conducted him to the invention of the radiometer led him to work with excessively high vacua. In connection with this he found that an electric discharge in such vacua is capable of exciting effects of phosphorescence apparently quite different in their origin from those produced in the ordinary way by such discharges. The latter are clearly referable to the action of the ethereal undulations which are propagated from the seat of the discharge. But

the former involve in some way the effect of the actual transference of the molecules of ponderable matter. These phenomena in the hands of Mr. Crookes opened up a new means of discrimination between different bodies, and he has applied them as a test for the discrimination of groups of rare earths, not yet fully investigated. The test went hand in hand with processes of chemical separation. But here a great difficulty presented itself. So very closely allied in their chemical properties are the members of the groups, that it was only by an excessively tedious and laborious system of fractional precipitation that Mr. Crookes was able to effect a pretty fair separation; even still, the separate existence of some members of the groups is more or less problematical. It is for these painstaking researches that the medal has been awarded.

The existence, or apparent existence, of so many earths of such close chemical relationship led Mr. Crookes to speculate on the possibility that after all the molecules of what is deemed a chemical element may not be absolutely alike, as chemists have almost universally believed, but only very approximately so, and that what is deemed the molecular weight of the substance may really be that of the average of its molecules. Should such groups exist, it is conceivable that by processes of very delicate chemical separation they might be split up again into sub-groups, the molecules of which still more nearly match one another; so that according to this view the number of groups into which an element, or what is deemed such, might be split up, not, be it observed, by any dissociation, but merely by a sorting of the molecules which are very nearly alike, may be somewhat indefinite.

Chemists will not probably be disposed to give up the idea of the perfect similarity of the individual molecules of elementary bodies; but it is surely legitimate for one who has worked so assiduously at these difficult separations to suggest, merely as a matter for chemists to think about, a possible view of the nature of elements different from that to which they have been accustomed.

PRESENTATION OF A PORTRAIT OF PROFESSOR A. W. WILLIAMSON, F.R.S., TO UNIVERSITY COLLEGE.

On Wednesday (12th instant) a portrait of Prof. A. W. Williamson, late Professor of Chemistry in University College, London, was presented to the College by Sir Henry E. Roscoe, M.P., F.R.S., on behalf of the committee of subscribers. The portrait is painted in oil by the Hon. John Collier.

The presentation took place in one of the lecture rooms, the Chair being taken by the President of the College (Mr. John Erichsen, F.R.S.), and amongst those present were Sir F. A. Abel, Prof. Bonney, Prof. H. Morley, Dr. J. H. Gladstone, Prof. George Carey Foster, Dr. Atkinson, Prof. Ramsay, Prof. Thorpe, Prof. Marks, Prof. Russell Reynolds, and other professors, and a large number of the past and present students of the College.

Dr. W. J. Russell, on behalf of the Committee, for whom he had acted as Treasurer, said—Judging from the subscription list, there was a large number of the former colleagues of Prof. Williamson who had subscribed to this portrait, and it would no doubt be very pleasant to him to know that members of all the chemical societies in England had liberally subscribed towards the portrait, and further, that many of the subscribers had not satisfied themselves by sending formal contributions, but had written to him (Dr. Russell) expressing their great esteem and regard for Dr. Williamson. The subscriptions not only came from all parts of Great Britain, but from France, Germany, Switzerland, Italy, Russia, and even so far afield as the United States, Jamaica, India, and Japan. He thought this was all that it was necessary for him to say in order to indicate the high value which the subscribers attached to the great scientific attainments and labours of Dr. Williamson, whose intimate friends and old pupils, who knew him best, now came forward to pay him this mark of their esteem and regard.

Sir Henry Roscoe—I consider it, Sir, a privilege that, as an old pupil and an attached friend of Dr. Williamson, I should have been chosen on this occasion to present his portrait—which I think you will all consider as a life-like one—by Collier, to the College in which he laboured so faithfully and so successfully for nearly forty years. The first appointment of Dr. Williamson dates, as you, Sir, are aware, from the year 1848, when, following Fownes, he was, as Professor of Practical Chemistry, placed in charge of the first teaching scientific laboratory established in England, and in a few years afterwards, on the resignation of Graham, he assumed the responsibility of the two Chairs of Chemistry. A favourite pupil of Liebig's, Williamson had, at Giessen, imbibed the scientific spirit of that great master, and had, at the early age of nineteen, published his first original investigation. Afterwards carrying on his studies in Paris, and becoming intimate with Laurent and Gerhardt, he brought to London the best traditions of the French as well as of the German schools of chemistry, uniting in his person the attributes of both. Entering upon his duties in this college with the enthusiasm for his science characteristic of his nation, was it to be wondered at that he should have imparted to the young men fortunate enough to have come under his influence some sparks of that fire which burnt so brightly in his own breast? I well remember the vivid interest, the keen appreciation, with which all those who studied in the Birkbeck Laboratory at that now distant time followed, step by step, the unfolding of his views on etherification and on the constitution of salts, which may truly be said to have laid the foundation of modern organic chemistry. All those of his pupils who then made up their minds to devote their lives to chemistry, whether in the walks of the pure science or in those of its applications, must willingly own that much of the success which they may have met with in after years is due to his teaching and example, and admit that in the receptive period of a man's life the influence exerted upon them by a teacher whose years were not far removed from their own, of high aims and of ardent temperament, could not fail to be inspiring. This is not the occasion to enquire into the position which Williamson holds as one of the great chemists of our time and country. Rather is it our object now to express the feelings of gratitude, and if I may be allowed to say so, of affection, which we who have been his pupils, and are his friends, as well as those of us who can only claim the latter but perhaps no less intimate relationship, entertain towards him. To assure him that we look back upon the times spent in personal conntact with him as some of the pleasantest as well as some of the most fruitful of our lives. And both pupils and friends here join to show their appreciation of his labours and of his character, and to acknowledge the debt which they and their science owe to him. This portrait, Sir, of our friend and master finds a fitting resting-place in the halls of the college in which his working years were spent. It will remain as a memorial of a teacher, an investigator, and a colleague whose main interest was to uphold and increase the renown of University College as a centre of intellectual progress, and of one whose character, both as a man and as a chemist, future generations, like our own, will delight to honour. It is now my pleasing duty to unveil the portrait, and to ask you, Sir, as the President of this College, to accept it on behalf of the subscribers.

The portrait was then exposed to view.

The President—In the name of and on behalf of the Council and Members of this College I accept with gratitude this admirable likeness of our dear colleague and friend, Dr. Williamson. Sir Henry Roscoe has truly said that this is not the place to dilate on Dr. Williamson's great scientific merit, and the great claims which he has

as a scientific man to any honour that could be bestowed upon him. I shall not venture on this subject, but I may say this: that, looking at Dr. Williamson's career, as I can do for the last forty years—thirty years of which he has been connected with this college, ten years as a governor — there never was a man more loyal to this institution and more devoted to its best interests than Dr. Williamson. The business of a Professor is here not only to teach but to take part in the management of the college, which, as you know, devolves individually and collectively upon them. It is in the meetings of the Council of the Senate that the devotion of the Professors to the interests of the College is shown quite as much as in the teaching of his classes. The College could not be worked without the business aptitude of the professorial staff, and in this duty of management none showed more zeal, loyalty, and devotion during thirty years than Dr. Williamson. We, as a governing body, must feel deeply indebted to him for the interest which he has shown in the welfare of this institution. But I should not be doing my duty if I were not to couple with his name that of his wife. Mrs. Williamson was as devoted as her husband, and did very much to raise the character of the school. She showed the greatest interest and enthusiasm in all the work which, as a woman, she was able to perform, and bring about harmony within the walls of this institution. Mrs. Williamson worked, side by side with her husband, with unwearied devotion in, as I have already said, the best interests of University College. Ladies and gentlemen, I can only add in my own name and in the name of this institution, the hope that Dr. and Mrs. Williamson will be followed with all health and happiness in their comparative retirement from further active work.

Sir Frederick Abel—Allow me to move a vote of thanks to the President of the College for his kindness in being the mouthpiece of many old friends in expressing as he has done the high respect and great affection entertained for Dr. Williamson by all his old colleagues. I desire to add that it is a great pleasure to me to be able to assist at this ceremony, and I for one am highly gratified at the lifelike portrait presented to the College, and accepted by you, Sir, as President on its behalf.

Dr. T. Anderson—As an old pupil of, and as an old dresser to, the President I have great pleasure in seconding the vote of thanks proposed by Sir Frederick Abel.

The President briefly acknowledged the compliment which had been paid him.

Dr. Williamson (who was received with cheers) said—I believe, Sir, that the reward which, upon the whole, is the most satisfactory (and which, perhaps, I may call the highest) which can be given to the man who has endeavoured to do his duty is the expression of approbation from men of high authority on the subject-matter on which he has worked. The compliments which have been paid to me to-day have been enhanced greatly by some words which Sir Henry Roscoe let fall, and which could not have come with greater weight from anyone than from my old friend. It is to me a proud feeling—one which gives me great satisfaction—that in the decline of my life and in the end of my career I should from such a man—a man of such high character and position—have received so cordial and friendly an expression of approbation and personal esteem. I must ask leave, Sir, to thank the Council and you as their head for the honour which you have done me in allowing my portrait to be placed within these walls, for, although I have been associated with other colleagues and have performed duties of other kinds, there is no place that I have felt it so great an honour to be connected with as University College, where I have been associated with so many men who have made noble, self-sacrificing efforts in the best interests of this institution. I look back with pride on my connection with my colleagues of this College, though I have often bitterly regretted that my intercourse with the students has not been more personal. Sometimes a man comes up to me, shakes me by the hand, and calls me by name, and I am obliged, to my shame, to confess that I do not know his name, which I am obliged to ask, and then I find he was an old student who knew me perfectly, remembered me lecturing in a long, dark room, in which I was visible to him though he was not visible to me. I have often very much regretted that I have not been brought into closer relations with this large body of earnest men and students. Still among those I have known I have found many esteemed friends. I do not think it desirable for me to make further remarks at present beyond expressing to Mr. Collier my appreciation of his success in making what is not an ugly portrait out of such an ugly face as mine.

The proceedings then terminated.

In the Evening, at the Freemason's Tavern, Dr. Williamson was entertained at Dinner by a goodly number of his pupils and friends. Sir Henry Roscoe, M.P., F.R.S., presided.

After the toast of "The Queen" had been given and duly honoured, Mr. Carteighe, one of the Honorary Secretaries, announced that a considerable number of letters from subscribers had been received expressing their regret at not being able to be present. The one from Prof. Michael Foster, F.R.S., referred humourously to Dr. Williamson as the "Ether Meister."

Sir H. Roscoe, in proposing the toast of the evening, "Our Guest, Dr. Williamson," referred in kindly and affectionate terms to his early association with him, to his enthusiasm as a teacher, and the influence which it exerted on all his pupils, and to the respect entertained for Dr. Williamson by men of science in all parts of the world.

Dr. Williamson, in reply, expressed the gratification which this Dinner had afforded him, and referred with pride and satisfaction to the great honour which had been conferred upon him in the presentation of his Portrait to University College. In conclusion he wished any of his old pupils, present or absent at that gathering, when in the neighbourhood of Hindhead, to call and see him in his "nest."

Professor Norman Lockyer, F.R.S., proposed "University College and its President," and expressed his admiration at the excellence of the work in Science and Literature which had been carried out in that institution and the influence the College was exerting on scientific education.

Mr. Erichsen, F.R.S., President of University College, responded to the toast.

Professor W. H. Flower, F.R.S., proposed the health of the Professors of University College, and referred to the long roll of distinguished men who had filled Chairs in the College. He complimented the existing staff on their thoroughness and earnestness.

Professor Henry Morley responded for the Arts Faculty and Professor G. C. Foster, F.R.S., for that of Science.

Professor Ramsay, F.R.S., proposed "The Chairman," to which toast Sir Henry Roscoe replied.

Professor T. E. Thorpe, F.R.S., proposed "The Committee of the Williamson Testimonial," to which Mr. Michael Carteighe, President of the Pharmaceutical Society, and Dr. H. Forster Morley, the Honorary Secretaries, responded.

The entertainment concluded with a charming musical sketch given by Professor Ramsay, at the request of the Chairman.

On the Benzoic Acetals of Mannite and its Homologues: Decomposing Action of Benzoic Aldehyd.—J. Meunier.—When a benzoic acetal (and the same doubtless holds good for other acetals) is completely freed from the excess of aldehyd to which it owes its origin, it resists the action both of acids and alkalies; it is not decomposed by prolonged boiling with acidulated water, but if the aldehyd is present it is very rapidly decomposed on boiling.—*Comptes Rendus*, Vol. cvii., No. 23.

NOTICES OF BOOKS.

The Art of Dispensing: A Treatise on the Methods and Processes involved in Compounding Medical Prescriptions. Second Edition. London: Offices of the *Chemist and Druggist.*

Many of the directions here given will be regarded as matters of course by all persons familiar with chemical analysis or research. But the pharmaceutist has special demands to meet and difficulties to encounter, for which he must be well prepared, and to these points due attention is called in the work before us. Such are, *e.g.*, the neatness and the distinctness of labels, for which the type-writer is pronounced useful, and might, indeed, have a good claim to exclusive adoption.

A chapter on prescribers and dispensers discusses the questions of ambiguous nomenclature, from which surely the language of pharmacy ought to be free; the question of measurement; the graduation of medicine-bottles, the accuracy of which is not accepted; careless prescribers who have no rightful *raison d'être* and extra doses. The German law demands in this case the addition of the mark (!) to any unusual quantity. If this caution is omitted the consequences are visited not upon the prescriber but upon the dispenser. Of two cases here quoted, in the former the prescriber had omitted the mark, but had, instead, several times underlined the extra dose, potassium cyanide. On the death of the patient the pharmacist was condemned to a year's imprisonment. In another case the prescriber meant to order 4 grms. of chloral hydrate, but instead of 4·0 grms. he omitted the decimal point and wrote 40. In this case also, which gives an instance of the dangers of decimals in such matters as prescriptions, the pharmacist suffered a long imprisonment.

The dangers of making up prescriptions with spring or well-waters, and the changes which such a practice may produce, at least in the appearance of the medicine, are duly noticed.

A chapter is given on "Incompatibles," which sometimes manifest their mutual disagreement to the extent of a dangerous explosion, and show the necessity for the pharmacist of a very thorough knowledge of the possible reactions of all medicinal substances. We find an instance given of a prescription which resulted in the formation of nitrogen iodide!

Dispensing foreign—especially German—prescriptions must be a tribulation. In addition to the peculiar nomenclature which physicians and "apotheker" still indulge in, in which chlorides and iodides respectively figure as chlorates and iodates, there is the Gothic script. Of one prescription here reproduced in *fac simile* the author says:—"This prescriber looks like taking first prize for bad writing."

But the specimens of English prescriptions here given rank high in illegibility, and it is time that either public opinion or law should here step in. When a physician writes out prescriptions in his own consulting-room he would do well to have a type-writer at hand.

In this last section we regret to find the absurd term "caligraphy" twice used for "handwriting." The author should remember that caligraphy means ornamental writing, as distinct from and often opposed to that which is simply legible. If a synonym is wanted for handwriting why not say cheirography?

We are happy to say that this neologism, "caligraphy," is the only flaw which we find in an exceedingly useful and ably-written book.

Transformation of Terpilene into a Menthene.—G. Bouchardat and J. Lafont.—Natural menthol must be connected with the terpilene series. Menthol, $C_{20}H_{20}O_2$, has relations of composition with terpilenol or terpilene monohydrate, $C_{20}H_{18}O_2$, similar to those which exist between the allylic and propylic alcohols.—*C. R.*, No. 23.

CORRESPONDENCE.

ULTRA VIOLET SPECTRA OF THE ELEMENTS.

To the Editor of the Chemical News.

Sir,—The recent contribution of Messrs. Trowbridge and W. C. Sabine, which appeared in the Chemical News (vol. lviii., p. 247), entitled "Wave-Lengths of Metallic Spectra in the Ultra Violet," is one of considerable interest and indicates the skill of the authors in obtaining photographs with the concave form of Professor Rowland's gratings. For the determination of wave-lengths, a few details require attention which they do not mention in their paper. The method of working without a lens in front of the slit is liable to give rise to inaccuracies in the wave-lengths much greater than the limits of error assigned by them to their measurements. The authors have measured the lines of only a single metal, copper, and only a very small part of the spectrum of that element, namely, the region from wave-length 2369·9 to 1944·1. These facts alone render some of their conclusions open to criticism. I will very briefly touch upon these conclusions.

In the first place they state that "The difficulty in identifying lines and determining coincidences by employing the tables of metallic spectra in the ultra violet, published by the British Association, is illustrated by our work; for certain lines measured by Liveing and Dewar, which are identified by the committee with lines given by Hartley and Adeney, are in reality removed from each other, one or two lines intervening. In certain cases the lines of Liveing and Dewar are wholly beyond identification with those given by Hartley and Adeney."

For the purpose of identification I have always urged the publication of the photographs of spectra with the wave-lengths written over the lines, and the Royal Society possesses such a set of our spectra enlarged to three feet in length. When we found that our photographic enlargements would not be published we took the trouble to describe accurately the appearance of each one of the 3000 lines which we had measured, and we also quoted lineal measurements on the original photographs taken from prism spectra. We are thus able at any time to correct any measurements which may be erroneous or may have been erroneously quoted. That our spectrum of copper contains lines which are not easily identified with those of Liveing and Dewar is not difficult to account for, nor is it surprising that some of the lines are wholly beyond identification, for the following reasons:—(1). Liveing and Dewar's spectrum is from the arc, while our's is from sparks. (2). The measurements of Mr. Adeney and myself generally include all wave-lengths between 4725 and 2042·2. In the spectrum of copper our determination of *absolute wave-lengths* ceases at λ 2243·5, because above that point the lines were too feeble, unimportant, and ill-defined, and were therefore measured from prism photographs. This remark applies to a number of other lines lying between 2468·4 and 2277, which are indicated by italics in the *Phil. Trans.*, Part 1, 1884, p. 107. (3). All our measurements above 2329 are acknowledged by us to be so much less accurate than those in other portions of the spectra that they have been under revision during the last three years. For the practical purposes of chemical analysis they are accurate enough, and the lines are unimportant, but on theoretical grounds we have desired to obtain measurements of the most refrangible lines with the greatest accuracy possible and for every element. A little friendly correspondence with Professor Liveing and a comparison of our cadmium lines with those measured by Mr. Bell, the numbers for which were given in the *American Journal of Science* during last year, has shown that there is a remarkable agreement between our measurements when dealing with the same lines up to the

point above mentioned, but measurements of arc photographs cannot be compared with those from sparks.

The only conclusion that Messrs. Trowbridge and Sabine have arrived at which I can agree with is No. 4, "The limit of the copper lines is extended by our investigation."

No. 3 would bear modification; it stands thus—"Hypothesis in regard to coincidences of gaseous and metallic spectra cannot be safely based upon existing measurements of spectra in the ultra violet." This observation is not justified by photographs of only that portion of the spectrum of copper which was measured by Messrs. Trowbridge and Sabine, because it is here made to apply generally.

The most important part of Professor Grünwald's predicted and calculated spectra lie in a less refrangible region than the line 2320, that is to say where the measurements are more accurate. In conclusion I may add that Mr. Adeney is closely occupied on the most refrangible portion of the several ultra violet spectra which we have photographed, and early in the new year we hope to be in a a position to publish something further on the subject.—I am, &c.,

W. N. Hartley.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 23, December 3, 1888.

The Preparation of Phosphorescent Strontium and Calcium Sulphides.—E. Becquerel.—The presence of very minute proportions of certain compounds in the preparation of the alkaline earthy sulphides is sufficient to modify the colour, the intensity, and duration of the light emitted. Thus, on preparing calcium sulphide by the recalcination of a mixture of oyster shells previously calcined along with sulphur, the addition of 1 to 2 per cent of manganese dioxide produces a mass having a fine yellow phosphorescence. Potassium persulphide, used in the same manner, causes the emission of a green light; with componnds of bismuth the light is blue and very persistent. Some of these additional substances, if used alone, produce no appreciable effect, and the joint presence of several of them is necessary.

The Black Waters of the Equatorial Regions.—A. Müntz and V. Marcano.—Certain affluents of the Orinoco and the Amazon have what is called black waters (*aguas negras*). When seen in mass they are of a coffee-brown or of a greenish black. In the shade they are almost black, but in a glass they are brownish yellow, though very transparent. They have no disagreeable taste and are preferred for drinking. The samples of these waters brought for analysis by V. Marcano are slightly acid, and contain, per litre, 0·028 grm. of humic compounds. There is no lime (less than 0·001 grm. per litre), nitrates are totally absent, and the total inorganic solids do not exceed 0·016 grm. per litre. They include silica, alumina, iron, and manganese oxides and potassa, with traces of ammonia. They do not undergo any chemical change on keeping.

Action of Carbon Disulphide on Clays; Production of Carbon Oxysulphide.—Armand Gautier.—The author fills a wide porcelain tube with china-clay previously ignited to nascent redness. The apparatus is placed in a good furnace, where it can be heated to white redness. The air is first expelled from the tube by a current of carbon dioxide and a current of the vapour of dry carbon disulphide is then passed over. The gaseous mixture issuing from the tube is composed of a trace of hydrogen sulphide, about 1 per cent of carbon dioxide, 60 to 64 per cent carbon oxysulphide, 35 to 39 per cent carbon monoxide, all mixed with vapours of sulphocarbonic acid. The gas is richer in carbon monoxide if the temperature falls, but in oxysulphide if it rises. The clay is converted into aluminium sulphosilicate.

On Dioxethylic Acetone.—E. Grimaux and L. Lefévre.—This paper is not well adapted for abstraction.

On Phthalimidine and Methyl Phthalimidine.—Phil. Barbier.—The composition of methyl-phthalimidine may be expressed by the formula C_9H_9NO.

MISCELLANEOUS.

Royal Institution of Great Britain.—The following are the arrangements for the Friday Evening Meetings before Easter, 1889:—

Jan. 25th. Professor G. H. Darwin, M.A., LL.D., F.R.S.—"Meteorites and the History of Stellar Systems."

Feb. 1st. Professor W. C. McIntosh, M.D., LL.D., F.R.S.—"The Life-History of a Marine Food-Fish."

Feb. 8th. Sir William Thomson, D.C.L., LL.D., F.R.S.—"Electrostatic Measurement."

Feb. 15th. Professor A. W. Rücker, M.A., F.R.S.—"Electrical Stress."

Feb. 22nd. Harold Crichton-Browne, F.R.G.S.—"In the Heart of the Atlas."

March 1st. Edmund Gosse, M.A., Clark Lecturer in English Literature at Trinity College, Cambridge.—"Leigh Hunt."

March 8th. Professor Oliver Lodge, LL.D., F.R.S.—"The Discharge of a Leyden Jar."

March 15th. Sir James N. Douglass, F.R.S., M.Inst.C.E.

March 22nd. Professor Edgar Crookshank, M.B.—"Microbes."

March 29th. A. Gordon Salamon, F.C.S., F.I.C.—"Yeast."

April 5th. The Rev. Canon Ainger, M.A.

April 12th. The Right Hon. Lord Raylelgh, M.A., D.C.L., LL.D., F.R.S.—"Iridescent Crystals."

NOTES AND QUERIES.

Science and Art Department.—According to the Science and Art Department students in organic chemistry will be required to analyse mixtures containing not more than two of the following acids (with mineral base or bases):—Salicylic, oxalic, formic, acetic, and tartaric. Can any of your readers give me a scheme for the work, or say where I will find a method? I know the reactions of the acids, but cannot construct a table.—Student.

MEETINGS FOR THE WEEK.

Thursday, 27th.—Royal Institution, 3. "Clouds and Cloudland," by Professor Dewar. M.A., F.R.S.

Friday, 28th.—Quekett Club, 8.

Saturday, 29th.—Royal Institution, 3. "Clouds and Cloudland," by Professor Dewar, M.A., F.R.S.

PATENTS, DESIGNS, & TRADE MARKS ACT, 1883.

In the matter of an application by Ralph Waldo Emerson MacIvor, of St. George's Club, Hanover Square, in the County of Middlesex, for Letters Patent for "Improvements in the production of white lead or carbonate of lead and the apparatus therefor," dated the 18th July, 1888, No. 10426.

NOTICE IS HEREBY GIVEN that the said R. W. E. MacIvor has applied for leave to amend the Specification numbered as above.

A copy of the Specification in which the proposed amendments are shown can be inspected at the Patent Office; and particulars thereof were set forth in the Official Journal of the Patent Office issued on the 8th of December, 1888.

Any person intending to oppose the said application must leave notice of objection thereto (on Form G) at the Patent Office, 25, Southampton Buildings, London, W.C., within one Calendar month from the date hereof.

Dated this 8th day of December, 1888.

(Signed)
H. READER LACK, Comptroller-General.

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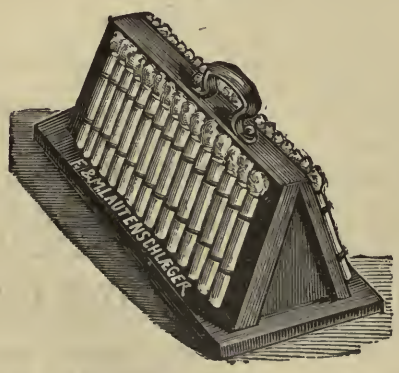

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THE CHEMICAL NEWS.

Vol. LVIII. No. 1518.

THE STANDARD OF ATOMIC WEIGHTS.

By BOHUSLAV BRAUNER, Ph.D., F.C.S.

I wish to direct the attention of chemists to the numbers representing the atomic weights of our elements and to the basis which they are referred to.

Since the publication of Stas's classical researches (Part 2, 1865) two different bases were introduced, namely, (*a*) H = 1·0025, O = 16, and (*b*) H = 1, O = 15·96.

Two leading chemists have given in special articles (I do not mention treatises, &c.) preference to each of these bases.

Marignac (*Archives des Sci. Phys. et Nat.* (3), x., 3—6, 1883) prefers the system O = 16, H = 1·0024 for the following reasons:—

1. The atomic weights of all elements (except Al and Zn, see below) are determined either directly or indirectly with regard to oxygen, this being the only element whose relation to hydrogen has been determined directly. To assume hydrogen as the unit involves one error more for every atomic weight determination.

(Even in the case of such elements as Al and Zn, the atomic weights of which have been determined with direct reference to hydrogen, the *weight* of the latter has to be calculated from its *volume*, assuming that one litre of hydrogen weighs 0·08958 grm. This value, after application of the "*Rayleigh correction*," becomes 0·08988, or higher by 0·33 per cent, and the atomic weight of the element in question is lower by the same amount. So Zn = 65·5 becomes 65·3, and Al = 27·0 becomes 26·9.)

2. The relation of H : O is difficult to determine, for this reason: it is likely to be altered by subsequent experiments (see below). This involves the alteration of *all* other atomic weights.

3. When O = 16, many atomic weights become whole numbers without becoming inexact, *e.g.*, C = 12, &c., this being of advantage for the calculation of analyses.

4. The basis O = 16 may be accepted without Prout's hypothesis being regarded as true, for this value is just as arbitrary as H = 1 or O = 1 or O = 100.

Lothar Meyer and Seubert (*Berl. Ber.*, xviii., 1089—1097) bring forward several reasons for the basis H = 1, O = 15·96, and again O = 16, which later value, according to these chemists, seems to have been accepted chiefly from love for Prout's hypothesis. The reasoning of the said authors cannot be expressed in a few words. They admit that all atomic weights will have to be changed as soon as the ratio of oxygen to hydrogen is better determined, and they say they will be the first to re-calculate all atomic weights accordingly.

The time for such a re-calculation seems to have arrived now, several important researches having been published lately, the object of which is to fix the ratio H : O more exactly. The values now obtained, together with the principal ones previously accepted, are given in the following list, the atomic weight of hydrogen being taken as unity, and the values for oxygen going from the highest to the lowest.

1. Scott, 1887 (*Proc. Roy. Soc.*, xlii., 396—400; Chem. News, lvi., 173—175), finds the composition of water by volume, H = 1·994, O = 1. When the density of oxygen referred to hydrogen is 15·9627, we get the ratio of atomic weights:—

$$H : O = 1 : 16{\cdot}01 \quad . \quad . \quad . \quad . \quad (1).$$

2. Dumas, 1842, also Ostwald, 1884 (*Lehrb. der Allg. Chemie*), calculate from the composition of water by weight—

$$H : O = 1 : 16 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2).$$

3. Clarke, 1882 (Recalculation, &c.), assumes, as most probable, the ratio—

$$H : O = 1 : 15{\cdot}9633 \quad . \quad . \quad . \quad . \quad (3).$$

This, with Le Conte's correction (*loc. cit.*, p. 7) becomes—

$$H : O = 1 : 15{\cdot}9622 \quad . \quad . \quad . \quad . \quad (3b).$$

4. Stas, 1865, L. Meyer and Seubert, 1883 (Atomgewichte, &c.)—

$$H : O = 1 : 15{\cdot}96 \quad . \quad . \quad . \quad . \quad . \quad (4).$$

5. Van der Plaats, 1886 (*Ann. Chim. Phys.* (6), vii., 529) remarks, in a footnote:—"Par la détermination de l'eau qui est produite par l'oxydation d'un volume connu (15 litres) d'hydrogène, j'ai trouvé récement pour ce rapport 15·94 à 15·96." This gives the ratio—

$$H : O = 1 : 15{\cdot}95 \quad . \quad . \quad . \quad . \quad . \quad (5).$$

6. Keiser, 1888 (*American Chem. Journ.*, x., 249), obtained quite recently by the combustion of known quantities of hydrogen, weighed as palladium hydride, the ratio—

$$H : O = 1 : 15{\cdot}9492 \quad . \quad . \quad . \quad . \quad (6).$$

7. Crafts, 1888 (*Comptes Rendus*, cvi., 1662), has determined experimentally the "Rayleigh correction," due to the compression of exhausted vessels used by Regnault for the density determinations, and, after its application to Regnault's experimental data, he calculates that the relative densities of hydrogen and oxygen are represented by the numbers—

$$H : O = 1 : 15{\cdot}911 \quad . \quad . \quad . \quad . \quad (7).$$

This, calculated with Scott's ratio of volumes, 1·9965, gives the atomic weights—

$$H : O = 1 : 15{\cdot}939. \quad . \quad . \quad . \quad . \quad (7a).$$

8. Lord Rayleigh, 1888 (*Proc. Roy. Soc.*, xliii., 356—363), calculates from the relative densities of hydrogen and oxygen with Scott's ratio, 1·9965, the following atomic weight.—

$$H : O = 1 : 15{\cdot}912. \quad . \quad . \quad . \quad . \quad (8).$$

9. Stas, 1882 (*Mém. Roy. Ac. Belg.*, xl., 1—99), has determined the relation of silver to ammonium chloride and bromide volumetrically with a mathematical exactness never reached before, and finds the "molecular weight" of ammonium, $NH_4 = 18{\cdot}078$ when O = 16. (This value has been calculated by Van der Plaats, instead of 18·076, as given by Stas himself). Unfortunately there exists an uncertainty whether, in the case of the synthesis of silver nitrate from the metal (Stas-Aronstein, p. 315), the *dried* or the *fused* silver nitrate corresponds to the formula $AgNO_3$, and so the atomic weight of nitrogen varies from 14·04 to 14·06, and of hydrogen consequently from 1·0095 to 1·0045. Assuming, however, that the dried silver nitrate contains a trace of water, and that the fused nitrate loses this water, together with a trace of nitric acid, so that the *mean value* corresponds to the formula $AgNO_3$, the atomic weight of nitrogen becomes N = 14·049, and consequently H = 1·00725.

But 1·00725 : 16 = 1 : 15·8848. The result is the ratio—

$$H : O = 1 : 15{\cdot}885 \quad . \quad . \quad . \quad . \quad (9).$$

10. Lord Rayleigh (*loc. cit.*) obtains from the relative densities of hydrogen and oxygen directly the following ratio—

$$H : O = 1 : 15{\cdot}884 \quad . \quad . \quad . \quad . \quad (10).$$

11. Cooke and Richards, 1888 (*Am. Chem. Journ.*, x., 81—110, and 190—196). The weight of water formed from known quantities of hydrogen weighed in the gaseous state was determined. After application of the "Rayleigh

correction" to the result, obtained directly, viz., 15·953, the following ratio was found—

$$H : O = 1 : 15{\cdot}869 \quad . \quad . \quad . \quad . \quad (11).$$

This is the lowest value of all, and it is not improbable that it is due to the unavoidable presence of a small quantity of nitrogen in the hydrogen used.

The following calculation shows the way in which the atomic weights of other elements are changed by changing the basis. As examples are taken the atomic weights of antimony (Cooke) and of uranium (Zimmermann), the one element standing in the middle and the other at the end of Mendeleeff's continuous series of elements :—

H=1.

	O=	Sb=	U=
1.	16·01	119·99	239·76
2.	16	119·91	239·61
3.	15·9633	119·64	239·06
3*b*.	15·9622	119·63	239·04
4.	15·96	119·61	239·01
5.	15·95	119·54	238·86
6.	15·9492	119·53	238·85
7*a*.	15·939	119·45	238·70
8.	15·912	119·25	238·29
7.	15·911	119·24	238·28
9.	15·885	119·05	237·89
10.	15·884	119·04	237·87
11.	15·869	118·93	237·65

It is seen that in the case of antimony the variation represents *one unit*, with uranium more than *two units*, and generally no less than 0·008885, or nearly *one per cent* of the value of the atomic weight of every element.

Our atomic weights are regarded as "Constants of Nature." Their values may of course be found to vary *slightly* owing to fortuitous errors incidental to their determinations, as in every human measurement.* This difference between the true numbers and the numbers found may, however, be lessened with every more exact determination.

But if we take hydrogen as a unit (H=1) the said "*Constants*" *will be found to vary considerably, the basis* (H=1) *remaining constant*, according to the possible variation of the "atomic weight" of oxygen from 15·869 to 16·01. Would it not then be paradoxical to call the atomic weights of elements under these conditions "*Constants* of Nature"?

Why should we make our atomic weights, dependent on the ratio of hydrogen to oxygen, a value which, besides changing from experiment to experiment, is the *most difficult* of all atomic ratios to determine accurately, its slightest variation causing *all* other atomic weights to vary the more the higher they are?

One way to get out of the difficulty would be to take *oxygen* as unity, viz., O=1 or O=100. This would, however, give numbers perfectly impracticable and absolutely impossible to remember.

Would it not be better to assume O=16 (without regarding Prout's hypothesis in its original rough form as correct) so as to make the atomic weights of all elements real "Constants of Nature" depending on a *constant basis*, and to change their values only when a more exact determination replaces a previous less exact one.?

Bohemian University,
Prague, December 9, 1888.

* I do not mean the variation of atomic weights, already admitted by Cooke, Schützenberger, Butlerow, and to some degree by Crookes, which has been treated lately in a pamphlet by E. Vogel, M.D., of Alameda (San Francisco: The Bancroft Company, 1888), who, however, in *some cases at least*, seems to have overseen that the supposed variation falls within the limits of unavoidable experimental errors. With regard to that question the following passage in Mendeleeff's classical paper on the "Periodic Law" (1872) seems to me to deserve closer attention. "The weight is evidently due to a peculiar motion of matter, and there is no reason to deny the possibility of transformation of this motion into chemical energy or any other form of motion."

AN INVESTIGATION OF A CASE OF GRADUAL CHEMICAL CHANGE.*

By W. H. PENDLEBURY and M. SEWARD.

The case of gradual chemical change with which the present investigation deals is that between hydrogen chloride and potassium chlorate, and also its action on a mixture of hydrogen chlorate and potassium chloride.

When dilute solutions of a chlorate (as for instance, potassium chlorate) and hydrogen chloride are mixed together, the liquid slowly acquires a chlorous smell, and there is a gradual liberation of oxidising material, chlorine, and oxides of chlorine. These immediate products cannot easily be investigated, for if the mixture is left to itself so that they accumulate in it, the gradual reaction first observed is stopped, and there ensues decomposition of the usual complex nature of these unstable solutions of chlorine and its oxygenated compounds.

But if a small quantity of potassium iodide is present it will be decomposed by these substances, and iodine will be gradually liberated as the final product of the reaction we have mentioned.

Now, Messrs. Harcourt and Esson, in their work on a gradual chemical change, measured the rate at which iodine was liberated in a liquid by ascertaining the time taken for a known quantity of sodium thiosulphate added to that liquid to be entirely decomposed. A small quantity of starch solution was added at the same time, and served as the signal of the presence of free iodine, which meant that the measured quantity of sodium thiosulphate was exhausted. The observation to be made was of the interval of time which elapsed between the addition of the thiosulphate and the first appearance of a blue starch colouration.

The same measurement and the same signal served our purpose. The first obvious difference between the two reactions is that, whereas in the former one (between hydrogen dioxide and hydrogen iodide) iodine was the primary result, in the later one it is a secondary result. This proved an unimportant difference. The secondary reaction between potassium iodide and the results of the first is, by comparison, instantaneous, not at all gradual. But another difference is of great importance. In their reaction the rate of decomposition became gradually slower, as one of the substances reacting continued to decrease sensibly in amount, and finally disappeared. In this reaction the amount of each substance decomposed bears an infinitely small ratio to the amount of each present; the composition of the mixture thus remains practically unchanged, and the rate of decomposition in each mixture is constant. Each experiment then is brought to an arbitrary close as soon as the constant velocity has been determined by the observation of a few intervals. The subjects of investigation were: the comparison of the velocities in different mixtures, and the establishment of laws connecting variation in velocity with variation of each of the ingredients.

In a large number of experiments hydrogen chlorate was used. Mixtures of dilute solutions of the two acids, chloric and hydrochloric, were made in various proportions, several series being taken, in each of which the amount of one of the acids present was varied in arithmetical progression, and the effect upon the rate investigated. Then the effect of the presence of certain quantities of potassium chloride upon the rate was observed, for the purpose of connection with a new series of experiments. In these potassium chlorate and hydrogen chloride were used, and series for variation of one of the ingredients taken as before. The effect of varying the quantity of potassium iodide present and that of varying the temperatures was also observed.

The results may be thus briefly summarised :—

Variation in Hydrogen Chlorate.—The rate varies with

* Abstract of a Paper read before the Royal Society, Dec. 13, 1888.

the amount of hydrogen chlorate, in the first place, directly, as the substance decomposed; and in the second place, with a small acceleration proportional to the quantity present, which thus has a coefficient of action independent of its being the substance decomposed. Thus—

$$R = aQ(1 + bQ),$$

where Q represents quantity, R rate, a and b constants.

Variation in Hydrogen Chloride.—The variation of the rate with that of hydrogen chloride is not of this simple nature. It would seem to be (1) an effect of the secondary order above mentioned (accelerative) on the decomposition of hydrogen chlorate by itself, and in addition to this (2) an effect of both primary and secondary order on the decomposition of hydrogen chlorate with hydrogen chloride.

Variation in Potassium Chloride.—The addition of this salt has a small accelerative effect on the normal rate proportional to its quantity. It thus appears to be a neutral salt not taking part in the reaction.

If a mixture of solutions of potassium chlorate and hydrogen chloride in proportion between 1 : 2 and 1 : 12 is made, complete double decomposition ensues; the hydrogen chlorate formed, in presence of the hydrogen chloride remaining, liberates oxidising material, and the potassium chloride formed exercises its specific influence on this reaction.

The secondary action upon potassium iodide producing iodine is practically an instantaneous one, unless the quantity of this substance is below a certain minimum. Below this the velocity observed in the mixture will be less than normal. The effect of increasing the amount of this substance to much greater than the minimum is closely analogous to that of a similar increase of any neutral salt.

The velocity is an exponential function of the temperature, as was observed in Messrs. Harcourt and Esson's investigations. As the latter increases in arithmetical progression, the former increases in geometrical progression. The rate is about doubled for a rise of 5° C. The ratio in this progression is not, however, absolutely constant, but varies a little with the temperature at which it is taken. Thus between 0° and 15° C. the rate is a little more than doubled for a rise of 5°; between 20° and 30° it is a little less than doubled.

POTASSIUM CHLORATE.

By Dr. HODGKINSON, F.R.S.E., and F. K. LOWNDES.

In a communication to the Chemical News (vol. lviii., p. 247) Mr. Warren drew attention to the so-called catalytic action of manganese on the decomposition of potassium chlorate by heat. It is very unlikely that any chemists really believe in such an action, although the term is still retained and used in a number of cases where the chemical action is obscure or has not been carefully investigated.

Without desiring to interfere with Mr. Warren's further prosecution of this subject, we venture to say that one of us made some experiments some years ago on this matter, and that we have repeated them lately in a slightly different manner.

Everybody knows the usual directions for making oxygen from potassium chlorate and manganese dioxide say, or imply, that the mixture shall not be too highly heated if pure chlorine-free gas is required.

If, instead of being careful in the heating, the chlorate be heated to complete fusion, and then a small quantity of manganese added, a sudden evolution of gas takes place, the particles of manganese "apparently" glowing as they come in contact with the chlorate. The oxygen contains more chlorine as the manganese is in finer powder and the purer it is. We have made some very pure MnO_2 by precipitating permanganate with alcohol, and washing from the potash and igniting, and with this the glow on contact with the fused salt is most noticeable, and much chlorine is given off. At the same time some manganese evidently unites with potassium in some way, for the fused mass assumes a strong pink colour, and on dissolving in water a pink solution may be obtained which contains manganese. But much of this manganese compound appears to be decomposed on the addition of water to the fused mass. It should be noted that, after the addition of the manganese, the chlorate is heated to redness until no more oxygen is given off.

With other oxides various results are obtained; oxides of zinc, magnesia, bismuth, antimony, copper, and tin gave little or no result, neither hastening the rate of evolution of oxygen nor liberating chlorine when dropped on the fused chlorate. With cobalt, lead, and iron oxides and commercial HgO red. there is an immediate increase in the rate of evolution of oxygen and traces of chlorine come with it. With the yellow oxide of uranium, tungstic anhydride, and both the yellow and blue molybdic oxide, MoO_3, and with V_2O_5 there is an immediate increased evolution of oxygen with *very much* chlorine, so much so with WO_3 and MoO_3 that the test-tube appears quite yellow from the presence of the gas. With tungsten, molybdenum, vanadium, and phosphoric oxides and chlorate there is a soluble potassium salt formed, as one might expect; also, with uranium oxide, there appears to be some uranate formed.

Generally the action seems most energetic with the oxides of those elements capable of forming higher acid oxides or anhydrides. Some ammonium salts also give rise to an evolution of chlorine when dropped into fused chlorate, but this may, to some extent at least, depend on the nature of the acid of the salt. The activity of manganese may arise from the formation of a small quantity of a manganate or similar compound, and the decomposition and re-composition of this under the conditions.

Substances like platinum black or platinised asbestos, when dropped on to fused chlorate, certainly cause an evolution of gas without any chemical action taking place on themselves: but it is only a slight action, and ceases after a little time. It is the action of points only in facilitating the escape of gas.

DEFINITION OF CHEMICAL ATOMS.

By Professor A. GRÜNWALD.

A "chemical atom," in the author's investigations, is none of the metaphysical atoms hitherto admitted. The "chemical atom" of his theory is a complex of exceedingly many moveable particles, which are elastic, but so intimately connected together that no chemical process which comes under our consideration is capable of severing their union and breaking the atom into fragments. The author does not even conceive of the parts of the "atom" as absolutely immutable, any more than the atom itself, but as capable within finite limits of undergoing modifications, which have definite relations to their mutual reactions.

This view renders it perfectly intelligible that an "atom" may have a spectrum consisting of very numerous rays of different wave-lengths. This spectrum varies, according to fixed laws, when the chemical condition of the substance consisting of such atoms and its relations to other substances vary. It is not impossible, and even probable, that the particles of an atom are identical with the particles of the ether, or with condensation forms of the ether.

It will be easily seen that in an intimate union of two atoms, in which they combine each with one or with several adjacent particles, the latter, which possibly in the free condition of the atoms perform vibrations of

different periods, after the chemical combination of the atoms, vibrate in an accordant manner, and may thus become true moveable nodal points, or ramification points of the molecules of the compound in question. This will find its expression in the spectrum of the compound in such a manner that it will have rays belonging to each component. On the disruption of the compound they will generally be resolved into two rays of different periods, one of which belongs to the spectrum of one of the constituents now set free, and the other ray to the spectrum of the other constituent. In this connection Prof. Grünwald calls rays whose wave-lengths (within errors of observation) belong simultaneously to two or more groups of rays, which represent different components of a compound in the spectrum of the latter "empirical" nodal or ramification rays of the groups concerned. Such rays may be real nodes or ramification rays of the compound. Or they may be possibly double or plural rays, the wave-lengths of which coincide very closely, so that they cannot be distinguished with certainty within the limits of error. Nevertheless they are distinct, and belong to two or more non-identical rays of different groups.—*Proceedings of the Imperial Academy of Sciences of Vienna*, vol. xcvi.

ON THE RAPID DECOMPOSITION OF INSOLUBLE, NATURAL, AND ARTIFICIAL SILICATES FOR THE PURPOSE OF QUALITATIVE ANALYSIS.

By ALEXANDER JOHNSTONE, F.G.S.
Assistant to the Professor of Geology and Mineralogy in Edinburgh University.

The *usual* methods employed in the laboratory to bring about the decomposition of insoluble silicates for the purpose of qualitative (and quantitative) analysis, are in the author's opinion unsatisfactory, for the following among other reasons:—First, while most of the methods are fairly sure, all of them are *slow*; second, a few of the modes, besides being slow, are uncertain; and third, even after the necessarily long time wasted in the preliminary work of decomposition, *traces* of at least the important alkali, potash, and several other bases, such as berylla, &c., cannot generally be *satisfactorily* identified.

In view of the above objections, particularly that of the tardiness of the processes involved, the author was led to adopt, after very considerable modification, the method of heating with solid ammonium fluoride, which was, he believes, first proposed by Bunsen, but afterwards strangely neglected by him and his followers, and by the chemical fraternity generally.

The modified process of decomposition of silicates by means of ammonium fluoride referred to is briefly stated and explained below by the author, who has used it for the last year with unbroken success while assisting in the work of teaching the practical geology and mineralogy classes of the University of Edinburgh.

A small, thin, and roughly circular layer of solid ammonium fluoride is placed on the bottom of a clean platinum crucible or on a clean piece of platinum foil. A little—say as much as will lie on a threepenny-bit—of the finely-powdered mineral or artificial silicate is now placed on the top of the thin layer of ammonium fluoride so as to cover it completely. The platinum foil or crucible is now, by means of the ordinary mouth blowpipe, heated until most of the ammoniacal fumes have gone off. The hydrofluoric acid fumes, in passing through the layer of silicate above, promote its rapid decomposition. When the fumes have nearly ceased to come off, another portion —a mere pinch—of ammonium fluoride is added to the top* of the silicate layer and pressed down into it, and heat is applied again until, as before, the fumes have almost stopped coming off. This operation of adding a mere pinch of ammonium fluoride and heating has to be repeated usually five or six times. When this has been done, and the whole process does not take up more than about eight minutes, the silicate will have been sufficiently decomposed to admit of the sure identification of the bases present.

The assay, after being heated strongly for an instant to drive off the last fumes completely, is now transferred to a small flask containing enough hydrochloric acid (about 40 p.c. solution) to cover it to the depth of about one inch. The acid liquid in which the assay is immersed is next evaporated rather more than one-third way down, and is then, after cooling a little, filtered off. The clear filtrate is now ready to be subjected to the ordinary methods of wet way examination for bases. Traces of lead, silver, and mercury may be found in the usual way in the undissolved assay residue. It is sometimes useful to examine also any flame colourations which this residue may give, by means of the spectroscope.

The author has by the above method found a ready and rapid means of distinguishing between the different species of felspar, mica, garnet, &c., &c.

Zircon (zirconium silicate), which is generally not well decomposed by other methods, undergoes complete, or almost complete, decomposition when treated *exactly* as stated above.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending November 30th, 1888.

By WILLIAM CROOKES, F.R.S.;
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To General A. De Courcy Scott, R.A.,
Water Examiner, Metropolis Water Act, 1871.

London, December 6th, 1888.

Sir,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from November 1st to November 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 182 samples examined during the month, the whole were found clear, bright, and well filtered.

Despite the swollen and unfavourable state of the rivers during the past month, the condition of the water supply to the Metropolis, derived both from the Thames and the Lea, has continued excellent. It is the admitted character of river-derived water to vary in composition, although for the most part within a very small range, from week to week, and month to month; and although it is satisfactory to know that during times of heat and drought, when the maintenance of a high standard of excellence in drinking water is more especially called for, the state of

* It would be better of course if the ammonium fluoride were placed *below* the silicate, but this is often not very conveniently accomplished.

the river as a source of supply is at its best, it is hardly less satisfactory to observe, by means of adequate storage reservoirs and filter-beds, how slight, for the most part, is the influence, upon the water-supply, of the less favourable condition of the river prevailing in rainy seasons. Although somewhat reduced by the results recorded during the month of August, the mean standard of purity for the four preceding months was decidedly high; and notwithstanding the altered condition of the river during the past month, in only one particular do the results obtained differ appreciably from the mean results of the previous four months; and that particular, namely, the degree of freedom from colour-tint when subjected not to mere inspection, but to the exact determination afforded by the colorimeter, not one of any weighty significance. As regards the proportion of organic matter present as measured by the determination of the organic carbon, the mean result for the month furnished by the Thames-derived supplies, was 0·164 part of organic carbon in 100,000 parts of the water, as against a mean of 0·159 part for the previous four months; during which time, moreover, the maximum proportion met with during the past month, or 0·191 part in 100,000 parts of the water, was in several instances attained and exceeded. In the case of the East London Company's water derived from the Lea, the difference was in the same direction and to a similar insignificant extent, the mean amount of organic carbon for the month being 0·155 part in 100,000 parts of the water, as against a mean of 0·148 part for the previous four months.

We are, Sir,
Your obedient Servants,
William Crookes.
William Odling.
C. Meymott Tidy.

PHOTOGRAPHY OF THE LEAST REFRANGIBLE PORTION OF THE SOLAR SPECTRUM.*

By J. C. B. BURBANK.

It has been stated by eminent authorities, that the process of staining dry plates with various dyes is not applicable to the photography of the invisible rays beyond the red of the solar spectrum. To test this question I have undertaken a series af experiments with the dye cyanine. This dye has of late come into considerable prominence in photography, owing to its orthochromatic effect when mixed with other dyes, such as chinoline-red, azaline, erythrosine, and eosine.

It was discovered by Greville Williams, an Englishman, in 1861, but did not come into much prominence until the year 1884, when its usefulness as a sensitiser became more apparent. The dye is easily decomposed by light, and even in the dark both its solution and the plates coated with it are apt to become decomposed if kept for any length of time. Alone, it has been found very useful to sensitise plates for the orange and red portions of the spectrum. No experiments have to my knowledge been made upon the effect of heat rays upon cyanine plates.

The direct action of absorbents in the infra red has not, hitherto, been tried with any success; moreover, it has been stated by so eminent an authority as Captain W. De W. Abney that it was impossible to make plates sensitive to any rays below the A of the solar spectrum by means of the addition of dyes to a film. It is true, however, that Major Waterhouse has succeeded by means of turmeric in obtaining evidence of the existence of a few lines on the less refrangible side of A, but in all cases except one these were reversed.

The plates employed were made by the M. A. Seed Co. of sensitometer 22. The method used in staining the plates and in the preparation of the dye is substantially the same as that employed by J. B. B. Wellington,* and is as follows:—

Fifteen grains of cyanine are gently heated (over a steam-bath) for from thirty to forty minutes in combination with 1 oz. of chloral hydrate and 4 ozs. of water. The whole mixture should now be stirred vigorously. While this operation is going on, 120 grains of sulphate of quinine are dissolved by heat in a few ounces of methylated spirit. (If methylated spirit cannot be obtained, a solution of 90 per cent alcohol and 10 per cent wood-spirits will answer perfectly well.) One ounce of strong aqua ammonia is now slowly added to the cyanine mixture above. Violent ebullition takes place immediately, chloroform being evolved, and cyanine is deposited in a soluble form on the sides of the vessel. The mixture is allowed to settle for a few minutes, and then the supernatant liquid is decanted off very slowly, care being taken not to detach any of the cyanine that is formed on the sides.

To the remaining cyanine, three or four ounces of methylated spirit are added to dissolve the cyanine; the quinine solution is then added; and to the whole more methylated spirit, until the whole mixture measures from eight to nine ounces. This solution constitutes the "stock" solution, and should be kept away from all light, as it is very apt to become decomposed.

All of the above operations should be conducted in as little light as possible; the following staining and drying processes should be conducted in absolute darkness.

To thirty ounces of water are added 1½ drachms of the cyanine stock solution; the graduate that contained the cyanine is now washed out, 1½ drachms of strong aqua ammonia are added, and the whole mixture is stirred vigorously. Into this bath two or three plates, or half a dozen strips, can be dipped at once. They should be left there about four minutes; meanwhile, the tray containing the plates should be rocked continuously, so as to ensure a uniform action of the dye.

This bath, after having been used once, should be thrown away, as the action on a second batch of plates would be weak and imperfect. The plates can now be drained, dried, and used. While developing, I was careful to exclude all light whatever, although I think it possible that the plates may be developed safely in a dark greenish yellow light. The developer used was a pyro, and potash developer of (generally) normal strength.

In the first experiments the spectrum was produced by a Rowland flat diffraction grating, mounted on a spectrometer circle. This grating contained 17,000 lines to the inch. The observing telescope of the spectroscope was replaced by a camera and lens.

Certain photographs were also taken by means of a Rowland concave grating of 14,500 lines to the inch, and of 21 ft. 6 in. radius of curvature. With this grating, the amount of light being less and the dispersion greater than in the former cases, the exposure had to be increased.

In all of the experiments ruby-red glass screens were used in order to cut out all of the more refrangible part of the underlying spectrum. In some cases a weak solution of iodine in carbon disulphide was used with good effect.

No difficulty was found in photographing from the A line to wave-length 9900, or to the limit assigned by Abney as the limit of the diffraction spectrum. None of the lines were reversed. A special study of the A group was made, photographs being taken at different seasons in order to see if any changes in the remarkable group of lines constituting the A group could be noticed. No existing map represents this group correctly. Employing the second spectrum produced by a concave grating, 52 lines were observed between wave-lengths 7100 and 8000. In the same space Abney records only 24 lines. Between the head of A and the tail of A, the latter being the

* Contributions from the Jefferson Physical Laboratory.

* See "Anthony Photographic Bulletin," December 24, 1887.

single line before the series of doublets begin which is so characteristic of the A group, my photographs show 17 lines. These photographs were taken in June between ten and one o'clock.

These results are of special interest when we consider that Abney has said in a Bakerian Lecture, "As a result of these experiments I can confidently state that in no case did the addition of a dye cause any chemical effect to be produced by the rays below A of the solar spectrum, nor has Vogel claimed that they do."

It is interesting to note that Abney is led to believe that the photographic action, which has been noticed hitherto, by the use of dyes as sensitives, can be attributed to a certain action of nitrate of silver on organic matter. This effect is a bleaching one, and only the more fugitive dyes can produce it. We are led to conclude from Abney's paper, that he believes that only a chemical effect produced in a specially prepared emulsion can be used to reproduce the infra red rays. After many experiments he succeeded in producing such an emulsion. The colour of this verged upon the blue. Since the colour of plates stained with cyanine by the process I have described is also blue, there may be some physical significance in this resemblance.

My experiments show that a specially prepared emulsion is not necessary for the photography of the infra red region. The chemical theory advanced by Abney, therefore, seems to need revision.—*Proceedings of the American Academy of Arts and Sciences.*

ON THE

FORMATION OF DEPOSITS OF OXIDES OF MANGANESE.*

By F. P. DUNNINGTON.

In explanation of the transfer of compounds of manganese, which has taken place in the formation of geological deposits, the only agency mentioned in works on chemical geology as taking prominent part is that of carbonated water, forming the soluble manganese bicarbonate. Dr. Bischof remarks† :—"With regard to the formation and alteration of manganese spar, the same relations obtain as in the case of iron spar." However, Fresenius has shown‡ that bicarbonate of iron and of manganese are obtained under different conditions. There is possibly a hint of the formation of manganese sulphate given by Karsten,§ but it is not definitely mentioned.

I propose in this article to call attention to the probability that manganese sulphate has taken a very important part in the formation of deposits of manganese ores.

Bunsen's analytic method for the valuation of manganese ores is based upon the fact that an acid solution of a ferrous salt will dissolve the higher oxides of manganese, with the formation of a corresponding amount of a ferric salt. Having observed the promptness with which such solutions are effected, I was led to make some examination of the action of similar solutions upon compact forms of oxide of manganese, and further, to ascertain some of the conditions under which solutions of ferrous sulphate, ferric sulphate, and manganese sulphate are decomposed. With this in view the following experiments were made:—

1. There was prepared a solution of ferrous sulphate and sulphuric acid in such proportions as would result from the oxidation of iron pyrites and solution in 25 parts of water. In 500 c.c. of this solution a lump of crystallised pyrolusite was suspended near the top of the liquid for forty-eight hours, resulting in dissolving a thickness of 0·804 m.m. (as calculated from the specific gravity of the mineral, area of the surface exposed, and loss of weight): a rate of solution equivalent to 6 inches in one year.

2. A lump of compact psilomelane was similarly suspended in the acid ferrous solution, and a thickness of 0·506 m.m. was dissolved in forty-eight hours, equivalent to 3·78 inches in one year. In each of the foregoing experiments a corresponding amount (45 and 12 per cent of the total) of the ferrous salt was converted to ferric.

3. A glass tube 3 c.m. in diameter and 20 c.m. in length, contracted at one end, was filled with a mixture of coarse powders of psilomelane, 75 grms., disintegrating pyrites (from Marienburg near Bonn), 100 grms., and glass. Through this tube two litres of water were allowed to percolate in the course of twenty-four hours, and in the liquid was found manganese sulphate, 7 grms., ferric sulphate, 1·45 grms., and sulphuric acid, 4·34 grms.

4. Through the above filled tube two litres more of water were similarly passed, and this dissolved of manganese sulphate, 0·154 grm., ferric sulphate, 0·07 grm.

5. Through the above filled tube two litres more of water were passed, while a continuous current of air was drawn through the tube; this dissolved of manganese sulphate, 0·292 grm., with about 0·07 grm. of ferric sulphate.

6. The glass tube was then re-filled, as at first, but using a bright granular pyrite (from Louisa Co., Va.). The current of air was kept up, and two litres of water, dropping at a uniform rate, were passed through the tube in the course of twenty-one days; this dissolved of manganese 0·098 grm. and no iron, while a small amount of ferric hydrate was formed and remained in the tube.

7. A neutral solution of ferrous sulphate digested *cold* with manganese carbonate, air being excluded, no change takes place; but when heated to 100° C. for two hours, considerable manganese sulphate and ferrous carbonate were formed.

8. Ferric sulphate solution reacts immediately upon manganese carbonate, forming manganese sulphate, ferric hydrate, and carbonic acid.

9. By reason of the fact, which is familiar, that ferrous sulphate solution is rapidly oxidised when exposed to the air, we find that when it is in contact with manganese carbonate, in the presence of air, the manganese carbonate is decomposed, forming manganese sulphate, &c., as above.

10. A neutral solution of ferrous sulphate with calcium carbonate, sealed in a tube under carbonic acid, was heated to 100° C. for two hours; mutual decomposition took place, forming ferrous carbonate and calcium sulphate.

11. Ferric sulphate solution reacts immediately upon calcium carbonate, forming calcium sulphate, ferric hydrate, and carbonic acid.

12. Ferric sulphate solution digested cold or hot with powdered manganese oxide was not altered.

13. Ferric sulphate solution was digested cold for nine days with sawdust and powdered psilomelane; considerable manganese sulphate was formed.

14. Manganese sulphate solution is not altered by exposure to air, but when so exposed, and also in contact with calcium carbonate, manganese oxide is gradually formed.

15. Manganese sulphate solution, digested cold with calcium carbonate in a sealed tube, is not altered; when heated, it is feebly affected, a little manganese carbonate being formed.

In view of the foregoing observations and results, it appears possible that many deposits of manganese in calciferous rocks owe their formation to the action of solutions of sulphates, and possibly an illustration of such action is presented in the manganese deposits of Crimora, Augusta Co., Va., which occur under the following conditions.

In the Shenandoah Valley, the upper portion of formation I. (Rogers) is composed of shales which are

* From the *American Journal of Science*, vol. xxxvi., Sept., 1888.
† "Chem. and Phys. Geol.," vol. i., p. 57, Trans. Cav. Soc.
‡ *Loc. cit.*, vol. iii., p. 531.
§ *Loc. cit.*, vol. i., p. 160.

well decomposed to a great depth, interspersed with remaining calciferous ledges, and as they pass westward these alternate with, and are succeeded by, ledges of siliceous limestone. In these decomposed shales, we find pure neutral iron ores, free from manganese, and associated with them there are manganiferous limonites and also psilomelane of high grade, frequently appearing to have grown in similar condition, and sometimes the same mass is composed in part of manganese and in part of limonite. South of the Potomac, no pyrites is visible in these shales, possibly owing to the great depth to which they have been decomposed; but at Harper's Ferry the iron ore lying in the same geological horizon has been worked down until compact pyrites has been reached. The presence of the pyrites in the latter renders it probable that it did exist extensively in the shales above described.

Assuming that pyrites did thus exist, generally distributed, we might expect a deposition of ores to have occurred in some such manner as the following.

Where pyrites has been deposited and subsequently has been exposed by reason of erosion, the outcrop is gradually converted into limonite by weathering, and the acid solution of ferrous sulphate, which sinks into the underlying deposits, must carry with it all manganese associated with the decomposing sulphide, also that in any disintegrating silicates and such as is distributed through the soil in the form of oxides or carbonate. As this solution is exposed to the air or meets with calcium carbonate, it will lose iron, the calcium carbonate removing all free acid, and an excess of the latter rock will remove all iron from the solution as ferrous carbonate, while the manganese sulphate would remain in solution until exposed to both air and calcium carbonate at the same time. Of course, the deposition of either iron or manganese oxides from solutions of sulphates by action of calcium carbonate results in the formation of calcium sulphate, which is carried away in solution in the water; so that the calcium is either wholly or in part removed from the strata in which such deposits are formed, and we would expect to find only occasional ledges remaining, as we find in the vicinity of the Crimora deposit.

An additional argument for the transportation of manganese as sulphate rather than bicarbonate lies in the great depth at which some deposits of manganese are found; for the bicarbonate would deposit oxide of manganese, wherever exposed to the air, while the sulphate would, where calcium carbonate had been previously removed, need to penetrate to a greater depth before reaching the conditions for its deposition. Moreover, the fact of the concentration of the manganese in masses rather than its general distribution through the decomposed shale would indicate that some condition additional to the exposure to oxygen had determined its deposition.

It is also to be noted that after all sulphur is removed from the overlying strata, the subsequent action of carbonated water might then occasion some transfer and redistribution of the previously formed deposits.

ON THE

CIRCULAR POLARISATION OF CERTAIN TARTRATE SOLUTIONS.*

By J. H. LONG.

The change in the circular polarisation of a solution of an active substance by admixture with an inactive one has been studied in several cases. Müntz found, for instance, that the specific rotation of cane-sugar for a concentration of 20 grms. in 100 c.c. changed from $[\alpha]_D = 66{\cdot}5°$ to $[\alpha]_D = 66{\cdot}3°$ by addition of 5 grms. of NaCl, and to 61·0° by addition of 20 m.grms.

The same chemist and others have shown the effects of adding various substances to sugar solutions. In most cases a decrease in the specific rotation was found.

Under certain circumstances the addition of an inorganic substance converts an inactive organic body into an active one, as in the case of mannite when in solution with alkalies, weak acids, and several neutral salts. Under still other circumstances the rotation of an active body can be very greatly increased by the addition of certain inactive ones, as is well illustrated by Gernez (*Berichte der Deutschen Chem. Gesell.*, xx., Ref. 251) in his experiments on mixtures of tartrates with molybdates, arsenates, tungstates, &c. He found, for instance, that the addition of NH_4MoO_4 to a solution of tartaric acid increased its rotation about fifty times.

This subject is one of great practical interest as well as of scientific importance, and it seemed to me that further investigation on the rotation of the tartrates must yield results of some value.

The following pages discuss results obtained with solutions of Rochelle salt in an investigation begun above a year ago, and which is still in progress.*

Apparatus and Methods.

In my experiments I employed a new model Laurent instrument made by Schmidt and Haensch, and used with this polarisation tubes 200 and 220 m.m. in length, surrounded by a water-jacket. The tubes were carefully measured and were found to differ so slightly from the given length (less than 0·05 m.m.) that I employ the whole numbers instead of introducing a fraction in the calculations, By means of suitable appliances the temperature of the solutions under examination was kept within 0·2° of 20°, as shown by a delicate thermometer. In most cases, however, this extreme accuracy in the control of the temperature was not necessary, as the variations caused by change of temperature were very small. In each test a dozen or more readings were made for each position of the analysing Nicol, and on the two verniers 180° apart. The instrumental error was almost inappreciable to begin with, and disappeared entirely by taking a mean of all the readings.

At a temperature of 20° a solution of tartaric acid containing 15 grms. in 100 c.c. showed a specific rotation $[\alpha]_D = 13{\cdot}03°$. This is diminished when the solution contains free mineral acids, and is also much diminished when certain neutral salts are added. With a solution containing 15 grms. of tartaric acid and 8 grms. of sodium chloride, I found the specific rotation less than one-half as much as before, viz., $[\alpha]_D = 6{\cdot}16°$.

If, instead of starting with tartaric acid, a neutral tartrate be taken and various salts added, quite different results are obtained. In the first place, the change in the specific rotation is much less than when the acid is used, and besides this the nature and amount of the change is characteristic of certain groups of salts. These points are shown below.

At the outset I prepared a quantity of pure Rochelle salt, sufficient for all experiments contemplated, and determined the rotation with five solutions containing exactly 5, 15, 25, 35, and 45 grms. in 100 c.c., measured at 20° C.

The results of these tests are given in the table, the specific rotation being calculated from the formula—

$$[\alpha] = \frac{10^4\ \alpha}{L.\ C.},$$

in which α is the observed angle of rotation, L the length of the tube containing the solution in m.m., and C the concentration of the solution, that is, the number of grms. in 100 c.c.

* *American Journal of Science*, vol. xxxvi., Nov., 1888.

* This investigation was begun before the work of Gernez came to my notice, and before the publication of recent papers by Landolt (*Berichte*, 1888, p. 191), in which reference is made to the behaviour of certain tartrates. A second paper will deal with other tartrate solutions.

T.	L. M.m.	C.	Sp. gr. ($\frac{0}{4}$).	a.	[a].
20°	200	5	1·0261	2·214°	22·14°
20°	200	15	1·0739	6·650°	22·16°
20°	200	25	1·1202	11·058°	22·12°
20°	200	35	1·1655	15·493°	22·13°
20°	200	45	1·2100	19·854°	22·06°

The specific rotation appears to be practically constant with the varying concentration, and the change in the angle of rotation by variation of temperature is inappreciable as I found by observing several of the solutions when heated to 35°. Krecke found (*Arch. Néerland.*, vii., 202), with a Rochelle salt solution containing 20 grms. in 100 c.c., the specific rotation $[\alpha]_D = 22·42°$ at 25° C. For a solution containing 10·771 grms. of the anhydrous salt in 100 c.c., Landolt found (*Berichte*, vi., 1073) $[\alpha]_D = 29·67°$, which is equivalent to 22·09° for the crystals.

This is practically the same as I obtained in the table above, and as I found it in numerous other tests carefully conducted I am inclined to think it is the true specific rotation. In what follows I will take 22·1° as the constant at 20°.

For each one of the following tests I took 20 grms. of the Rochelle salt and dissolved it in a narrow-necked flask graduated to hold 100 c.c. at 20°. Then the amount of the inactive salt was added and water enough to nearly reach the mark. After shaking, the flask was brought to the right temperature by suspending it in a large vessel of water kept at 20°. A little distilled water having the same temperature was added, and this was continued until, after shaking, the mark was just reached. The limit of error here is about one-twentieth of one per cent.

The solutions so made were then used in the polariscope. In all the experiments here given the temperature was kept at 20° and the 200 m.m. tube was employed.

The following table embraces the results obtained :—

Formula and amount of inactive salt added to 20 grms. of $KNaC_4H_4O_6 \cdot 4H_2O$ in 100 c.c.	Grms.	Observed rotation a. °	Specific rotation [a]. °	Deviation from Normal. °
NaCl	5	8·719	21·80	−0·30
NaCl	10	8·483	21·21	−0·89
NaCl	15	8·218	20·54	−1·56
NaCl	20	7·900	19·75	−2·35
NaBr	5	8·757	21·89	−0·21
NaBr	10	8·668	21·67	−0·43
NaBr	15	8·558	21·40	−0·70
NaBr	20	8·440	21·10	−1·00
Na_2SO_4 (anhyd.)..	5	8·669	21·67	−0·43
Na_2SO_4 ,, ..	10	8·526	21·32	−0·78
Na_2SO_4 ,, ..	15	8·376	20·94	−1·16
Na_2SO_4 ,, ..	20	8·200	20·50	−1·60
$NaNO_3$	5	8·688	21·72	−0·38
$NaNO_3$	10	8·604	21·51	−0·59
$NaNO_3$	15	8·514	21·29	−0·81
$NaNO_3$	20	8·426	21·07	−1·03
$Na_2HPO_4 \cdot 12H_2O$.	5	8·765	21·91	−0·19
$Na_2HPO_4 \cdot 12H_2O$.	10	8·721	21·80	−0·30
$Na_2HPO_4 \cdot 12H_2O$.	15	8·675	21·69	−0·41
$Na_2HPO_4 \cdot 12H_2O$.	20	8·630	21·58	−0·52
$Na_2S_2O_3 \cdot 5H_2O$ ..	5	8·744	21·86	−0·24
$Na_2S_2O_3 \cdot 5H_2O$ ..	10	8·611	21·53	−0·57
$Na_2S_2O_3 \cdot 5H_2O$ ..	15	8·497	21·24	−0·86
$Na_2S_2O_3 \cdot 5H_2O$ ..	20	8·365	20·91	−1·19
$NaH_2PO_2 \cdot H_2O$ ..	5	8·761	21·90	−0·20
$NaH_2PO_2 \cdot H_2O$ ..	10	8·575	21·44	−0·66
$NaH_2PO_2 \cdot H_2O$ ..	15	8·360	20·90	−1·20
$NaH_2PO_2 \cdot H_2O$ ..	20	8·127	20·32	−1·78
$NaC_2H_3O_2 \cdot 3H_2O$.	5	8·782	21·95	−0·15
$NaC_2H_3O_2 \cdot 3H_2O$.	10	8·681	21·70	−0·40
$NaC_2H_3O_2 \cdot 3H_2O$.	15	8·566	21·41	−0·69
$NaC_2H_3O_2 \cdot 3H_2O$.	20	8·450	21·12	−0·98
$Na_2B_4O_7 \cdot 10H_2O$ ..	10	8·729	21·82	−0·28
Na_2WO_4 (anhyd.) .	10	8·276	20·69	−1·41
LiCl (anhyd.)	6·752	8·172	20·43	−1·67
Tl_2SO_4	5	7·469	18·67	−3·43
KCl	5	9·088	22·72	+0·62
KCl	10	9·140	22·85	+0·75
KCl	15	9·228	23·07	+0·97
KCl	20	9·372	23·43	+1·33
KBr	5	9·087	22·72	+0·62
KBr	10	9·123	22·81	+0·71
KBr	15	9·172	22·93	+0·83
KBr	20	9·244	23·11	+1·01
Kl	5	8·918	22·29	+0·19
Kl	10	9·025	22·56	+0·46
Kl	15	9·105	22·76	+0·66
Kl	20	9·182	22·95	+0·85
KNO_3	5	8·986	22·46	+0·36
KNO_3	10	9·104	22·76	+0·66
KNO_3	15	9·239	23·10	+1·00
KNO_3	20	9·387	23·47	+1·37
KSCy	5	8·994	22·48	+0·38
KSCy	10	9·030	22·58	+0·48
KSCy	15	9·075	22·69	+0·59
KSCy	20	9·134	22·83	+0·73
$KC_2H_3O_2$	5	9·008	22·52	+0·42
$KC_2H_3O_2$	10	9·093	22·73	+0·63
$KC_2H_3O_2$	15	9·160	22·90	+0·80
$KC_2H_3O_2$	20	9·248	23·12	+1·02
K_2SO_4	5	9·040	22·60	+0·50
K_2SO_4	10	9·094	22·73	+0·63
$K_2C_2O_4 \cdot H_2O$ . ..	5	9·030	22·57	+0·47
NH_4Cl	5	9·033	22·58	+0·48
NH_4Cl	20	9·239	23·10	+1·00
NH_4Br	5	8·987	22·47	+0·37
NH_4Br	15	9·093	22·73	+0·63
$(NH_4)_2C_2O_4 \cdot H_2O$.	5	9·004	22·51	+0·41
NH_4SCy	10	9·036	22·59	+0·49

A simple inspection of the table shows immediately several important points. The addition of the sodium salts without exception causes a decrease in the rotation, which is greater as the amount of inactive salt is increased. The behaviour of the thallium salt is interesting; here a remarkable change is produced. Experiments now in progress promise to throw some light on the action of thallium compounds in parallel cases. The addition of potassium and ammonium salts without exception increases the specific rotation. This deviation becomes greater as more of the inactive salt is added. We have here a remarkable difference between the sodium, thallium, and lithium compounds on the one hand, and the potassium and ammonium compounds on the other. These peculiarities may sometimes be applied in the quantitative analysis of salt mixtures. These characteristic points and the amount of variation can be most conveniently shown by curves in which the abscissæ are the amounts of inactive substance in solution with 20 grms. of Rochelle salt and the ordinates the specific rotation of the mixture, or better, the deviation of this from a simple water solution of the tartrate.

I have drawn curves on this plan. Some of them are practically straight lines which can be represented by a simple equation of the form $[\alpha] = (\alpha)_0 + Ag$, in which g is the amount of inactive substance in solution, and $(\alpha)_0$ the calculated rotation when $g = 0$. It might appear that this value should be the same as that observed for the

pure tartrate solution, but I think that does not necessarily follow.

In the other cases the observations lead to a curve as expressed by $[\alpha]=(\alpha)_0+Ag+Bg^2$, in which the letters have the same meaning as before.

From the first three solutions containing potassium nitrate I have calculated according to this—

$$[\alpha] = 22{\cdot}20^\circ+0{\cdot}048g+0{\cdot}0008g^2.$$

I have not thought it necessary to find an interpolation formula for all the solutions. It is evident that they intersect the base line at $g=0$ only in a few instances, and the deviations are usually greater than could be referred to errors of observation.

As mentioned above, the addition of a potassium salt increases the rotation, while sodium salts diminish it. The numbers as given seem to show no relation beyond this. However, if instead of giving the rotation for solutions containing equal weights of active and inactive substance they be calculated for equal numbers of molecules in solution, the results obtained show certain regularities which must be more than accidental. These desired values can be obtained readily and accurately by graphic interpolation, and in the following table they were so derived.

[α]. *When for* 1 *molecule of tartrate* 1, 2, *or* 3 *molecules of inactive substance are present.*

Formula of salt.	1 mol.	2 mols.	3 mols.	
$NaCl$	21·86	21·41	20·99	
$NaBr$	21·79	21·42		
$NaNO_3$	21·68	21·41	21·16	
Na_2SO_4	21·32	20·49		
$Na_2HPO_4.12H_2O$ ..	21·40			
$Na_2S_2O_3.5H_2O$	21·07			(For ½ mol. =21·61).
$NaH_2PO_2.H_2O$	21·67	20·92		(For 1½ mol. =21·41).
$NaC_2H_3O_2.3H_2O$ ..	21·72	21·16		
KCl	22·73	22·88	23·14	
KBr	22·78	23·00		
KI	22·63	23·09		
KNO_3	22·60	23·07		
$KSCy$	22·52	22·66	22·82	
$KC_2H_3O_2$	22·60	22·87	23·25	
K_2SO_4	22·79			
NH_4Cl	22·54	22·67	22·81	
NH_4Br	22·54	22·70		

We see from the above that the specific rotation in presence of two molecules of $NaCl$, $NaBr$, $NaNO_3$, or one molecule of $Na_2HPO_4.12H_2O$, or 1½ molecules of $NaH_2PO_2.H_2O$ is very nearly the same, 21·41°.

In presence of one molecule of Na_2SO_4 it is a little less, while for $NaC_2H_3O_2$ and $Na_2S_2O_3$ no simple relation is apparent.

Two molecules of KBr, KCl, KI, KNO_3, and $KC_2H_3O_2$ exert nearly the same influence; one molecule of K_2SO_4 gives a smaller value, while $KSCy$ is irregular.

Roughly, it appears that the potassium salt molecules increase the rotation in about the same proportion that the sodium salts diminish it. The explanation of this may not be immediately apparent.

Cases similar to those observed in the experiments of Gernez, referred to above, have been explained by the hypothesis of Biot according to which loose combinations are formed between the active and inactive substance having a rotation different from that of the former. Gernez has given the composition of some of these molecular combinations. The case in hand, however, is somewhat different. If we could assume here an action of mass by which on addition of potassium salts the solution would be made to contain neutral potassium tartrate, and on addition of sodium salts neutral sodium tartrate, then the disturbance could be partially explanined. According to Landolt (*Ber.*, vi., 1073), the specific rotation of neutral potassium tartrate, calculated as anhydrous, is 28·48, while that of the neutral sodium salt is 30·85. However, if instead of taking equal weights as our basis we take equal numbers of molecules, we obtain the following values representing the *molecular rotation* of the three salts—

$$K_2C_4H_4O_6 = 64{\cdot}42$$
$$KNaC_4H_4O_6 = 62{\cdot}34$$
$$Na_2C_4H_4O_6 = 59{\cdot}85$$

from which it is apparent that the conversion of 20 grms. of Rochelle salt into the neutral potassium tartrate would give a solution with increased rotation, while conversion into sodium tartrate would give a solution with diminished rotation. On this assumption the change can be accounted for in part, but only in part. Taking the rotation for the mixture of 20 grms. of $KNaC_4H_4O_6 . 4H_2O$ with 20 grms. of KCl, given in the table above, we have $\alpha=9{\cdot}372^\circ$. Now, considering this as produced by 16·03 grms. of $K_2C_4H_4O_6$—the equivalent of 20 grms. of $KNaC_4H_4O_6 . 4H_2O$—we obtain a specific rotation—

$$[\alpha] = 29{\cdot}23^\circ.$$

which is too much, Landolt's value being 28·48.

In the same way, taking the rotation $\alpha=7{\cdot}900^\circ$ found for the solution containing 20 grms. of $KNaC_4H_4O_6.4H_2O$ and 20 grms. of $NaCl$ and supposing this rotation produced by 13·76 grms. of $Na_2C_4H_4O_6$, we find the specific rotation

$$[\alpha] = 28{\cdot}70,$$

which is too low, or, in other words, *too great a reduction*, Landolt's value being 30·85.

It will be seen, however, that the rotations found for the mixtures of the tartrate with the equivalent of two molecules of the simpler inactive salts give numbers which agree with Landolt's values. This is probably more than a mere coincidence. I am at present making a somewhat closer study of it.

The above mentioned hypothesis, while not adequate to explain fully the difference in behaviour between the inactive salts added to the tartrate, is still worthy of consideration, I think. In the further progress of the work I shall test it fully. The phenomenon is evidently a complex one, and the study of the behaviour of other double tartrates must be made before it can be thoroughly understood,

Preliminary experiments indicate that the double tartrates containing thallium or antimony will well repay investigation. The necessary material for such a study is now in course of preparation by an assistant in my laboratory, and with this I hope to be able to throw more light on the subject.

NOTICES OF BOOKS.

A Correlation Theory of Chemical Action and Affinity. By T. WRIGHT HALL, M.D. London: Remington and Co.

THAT a complete chemical theory capable of harmonising and interpreting the reactions which we encounter is still lacking must be conceded, though signs of a converging movement towards that goal are not wanting. Nor do we know that, however difficult, it would, as Dr. Hall thinks, be unpopular. We at least may venture to declare that any theory or instalment of a theory promising to solve the fundamental problems of the science will encounter at our hands, not the pillory, but a friendly greeting. But it must above all things be clearly intelligible. Neither the author of such theory nor any of his critics must be able to turn round and charge us with misinterpretation. Above all the new theory must legitimate itself by enabling us to understand and to predict phenomena. Dr. Hall's work seems to us deficient in

both these respects. The theory is nowhere stated plainly, and *totidem verbis* as a proposition to be proved, nor is it given in conclusion as an inference to be drawn. The reader may pick out a meaning—perhaps the right one—if he is able to understand every sentence of the book from beginning to end.

The author, in his preface and elsewhere, seeks to show a difference between the chemistry of our laboratories and the chemistry of the universe. He writes :—"The leading Themes in this Chemical Philosophy are—Gravity and Fire as Molecular Forces; and Matter's Form and Matter's Plasticity to those Forces. In our Chemical Philosophy, therefore, we do our little but our best to enthrone the cosmical, the enduring Chemistry of Nature, beside and above the local, the passing Chemistry of Art. In other words, I have tried to view Chemistry and its Forces and its Actions not only locally in piecemeals and in laboratories." Elsewhere he sneers at "the tiny Laboratories and the tinier Atoms and Molecules" as being insignificantly small and weak and as unfit to be the sole centre of chemical Phenomena and Thought."

But what evidence have we of the existence of two chemistries? What reason have we to suppose that, could we operate with quintillions of tons of matter instead of with milligrammes, we should meet with different reactions?

Dr. Hall seems to consider that solidity, not gaseity, is the original state of all matter, even of nitrogen and oxygen. He argues that "gaseity is given to air and most specially to the nitrogen air and to the oxygen air not only by heat but by very great heat force indeed, since very great cold is needed to cool these airs of their heat." Surely a strange reasoning!

On page 118 we read:—"The difference of charcoal from the diamond is so great that it warrants the assumption that charcoal would actually become sulphur if you changed its character befittingly." There is much virtue in an *if*. But, seriously speaking, let Dr. Hall once effect this transformation and we will proclaim him no sciolist, but the foremost chemist of the age!

Elsewhere we find cold spoken of as something other than a degree of heat, low in reference to our feelings or to our general experience. The author in this strain writes :—"The heat that is in oxygen will not burn man; the very great cold that is in carbon will not frostbite man."

Dr. Hall takes chemists to task for "speaking disrespectfully" of nitrogen as "azote," "chokestuff," a mere diluent of oxygen. But he must be aware that, save in these expressions, the value of nitrogen as one of the main essentials for the manifestation of life is fully admitted. We have heard it maintained that nitrogen had better be called "zote" than "azote."

We are told that certain "high-pitched cosmical spectral forces in Dayshine and Nightshine" are seen "unobtrusively gasifying and exploding daily and nightly billions of tons of nitrogen in our air." For this assertion we want evidence.

The moon is said (p. 284) to be "white hot."

We fear that Dr. Hall can scarcely be recognised as having contributed anything towards a theory of chemistry.

An Almanack for the Year of our Lord 1889. By Joseph Whittaker, F.S.A. Containing an Account of the Astronomical and other Phenomena, a Large Amount of Information respecting the Government, Finances, Population, Commerce, and General Statistics of the British Empire throughout the World, with some Notice of other Countries. London: 12, Warwick Lane.

It is a simple truism to say that Whittaker's Almanack still holds its pre-eminence. We have neither met with nor heard of any annual publication in any language which can hope to supersede it, or which does for any other country the same service which it performs for the British Empire. It is a marvel how such an amount of information, so varied, so useful, and in general so accurate, can have been brought together and compressed into a single manageable volume.

The only section which seems to us in need of amendment is that relating to societies. Political leagues and philanthropic and moral associations are mixed up with the learned societies. It would, we think, be a convenience if each of these classes were placed separately. A number of societies are omitted, which we shall not mention, as to advertise them is by no means our business. We must, however, regret the provincial learned societies—some of which are of considerable importance—and the "Society for the Advancement of Medicine by Research" are not mentioned. In the case of two chartered societies, the Institute of Chemistry and the Entomological Society, the initials which Fellows subjoin to their names are not given, and those for the Linnean Society are said to be F.Z.S., instead of F.L.S.

We mention these little points, knowing that the Editors of "Whittaker" aim at absolute accuracy.

Taking the book as a whole, it is an essential requisite not merely for the "Editor's Table," but for the study of the savant and the author, and not less for the office of the man of business.

The Asclepiad: A Book of Original Research and Observation in the Science, Art, and Literature of Medicine, Preventive and Curative. No. 20, Vol. v. By B. W. Richardson, M.D., F.R.S. London: Longmans, Green, and Co.

In casting our eyes over this journal we notice an article which will doubtless excite the interest of our readers. It is an account of some carefully conducted experiments on the respirability of hydrogen gas, its action upon the animal organism, and its possible use as an anæsthetic and a hypnotic.

The two last points are effectually decided in the negative. Upon warm-blooded animals it has no anæsthetic or hypnotic action, but proves rapidly fatal. The fatal effect, according to the author, is due to the gaseous obstruction which it places in the way of the blood in the capillaries, as well as to the deprivation of oxygen. Hydrogen does not enter into any combination with the blood, but is held merely in mechanical suspension, from which it is easily dislodged on exposure to the air. In cold-blooded animals life is suspended for a long time before it is finally destroyed, and in insects there is merely a suspension of animation even after very prolonged immersion in the gas.

The remaining papers in the number before us cannot legitimately come under our notice. The "morphine habit" has doubtless its interest for the physician and the ethicist. The "Art of Embalming" has a value in case of specimens which it is desirable to preserve for future examination. If applied to the dead generally it is simply a crime—an attempt to interfere with the circulation of matter.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. cvii., No. 24, December 10, 1888.

The Use of Hydrogen Peroxide for Determining the Metals of the Iron Group: 1st. Chromium.—Adolphe Carnot.—Oxygenated water produces, in the

solutions of the metals of the iron group, reactions sometimes oxidising and sometimes reductive, which are capable of utilisation in chemical analysis. The author proposes to examine these in succession. Chromic acid yields, with oxygenated water, a very remarkable reaction, first observed by Barreswill. It is a blue colour produced on mixing the cold dilute solutions of the two substances. This reaction is characteristic as well for hydrogen peroxide as for the chromates, provided that there is added a very slight excess of a strong acid, so as to set the chromic acid at liberty. The colour is very fugitive; it scarcely lasts for a few minutes if the solution is nearly neutral, and for a few seconds if it contains more than one per cent of free hydrochloric or sulphuric acid. Barreswill, the first discoverer, ascribed this reaction to the formation of an instable action, but Moissan has shown that it is due to the combination of chromic acid and hydrogen peroxide. M. Carnot finds that when the oxygenated water has completed its action the chromic acid is entirely reduced to the state of chromium sesquioxide, whilst a corresponding quantity of the hydrogen peroxide has been decomposed. This reaction consequently furnishes a means for the volumetric determination either of hydrogen peroxide or of chromic acid. The best method of conducting the process is as follows:—The solution of the chromate to be examined is placed in a flat-bottomed flask and diluted with water, if needful, to the bulk of about 50 c.c., neutralising with ammonia or with hydrochloric or sulphuric acid, so as to leave only a very slight acidity. As reagent is taken the oxygenated water of commerce diluted with 5, 10, or 20 volumes of pure water. In this state it is very stable at common temperatures. It is dropped from a burette into the flask containing the solution of chromate, which should be supported above a sheet of white paper. The first drops produce in the yellow liquid a series of dark spots, which soon disappear. Then the liquid takes a blue colour, which disappears also on shaking the flask. Finally, it takes a green tint more or less intense according to the proportion of chrome. We cease as soon as a drop no longer produces a blue spot, and note the volume of the oxygenated water consumed up to this moment. We then operate in the same manner with a measured volume of a solution of pure potassium dichromate of known strength. and the comparison of the volumes used renders it easy to find the proportion of chromic acid in the first solution. In order that the phenomena may be the more easily comparable in the two experiments, it is well for the volumes of the solutions and the proportions of chromic acid not to differ too widely. The final colour should not be too dark.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. Series 5, Vol. iii., No. 30.

This number contains no chemical matter except a notice of some experiments on magnesium and aluminium, taken from *Iron*.

Nos. 31 and 32.

These numbers contain no chemical matter.

Bulletin de la Société Chimique de Paris. Vol. l., No. 10.

This number is entirely filled up with extracts from other journals.

Archives Neerlandaises des Sciences Exactes et Naturelles. Vol. xxiii., Part iii.

This number contains no chemical matter.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Science and Art Department.—(Reply to "Student.")—After separation of the inorganic bases as usual the organic acids mentioned may be detected as follows:—In the absence of carbolic acid, the salicylic acid by the addition of Fe_2Cl_6 to neutral solution. Divide remainder of solution into two portions; distil one with dilute H_2SO_4—formic and acetic acids pass over and are detected, the former by $HgCl_2$ and the latter by Fe_2Cl_6. In remainder of solution the oxalic and tartaric acids, if present, are precipitated by $CaCl_2$, the precipitate washed, and *cold* NaHO added; $CaC_4H_4O_6$ dissolves and on boiling is reprecipitated. The CaC_2O_4 left on treatment with NaHO may be ignited to $CaCO_3$ and tested with HCl. Tables for the separation of organic acids will be found in "Jago's Chemistry," and "Jarmain's Qualitative Analysis."—W. E. Youle.

Manufacture of Cupels.—In the Fifth Edition of "Mitchell's Manual of Assaying," p. 143, referring to cupels, is the following statement:—It is very important that they should not contain carbon, and therefore, in making them, the bone-earth must not, as is sometimes recommended, be mixed with beer, or water containing adhesive substances. Nothing but pure water should be used," &c. For some months I have made a practice of mixing with the bone-ash several per cents of pure sugar or glucose, and when such cupels have been allowed to remain in the muffle thirty-five minutes before using, I have never been able to detect any ill effects from the practice. By this method, even when the best bone-ash is used, cupels much firmer and less liable to crack are produced, especially if it is desired to transport them or keep several barrels in stock. Will you please to state what the objection is to the practice, and greatly oblige one who is constantly receiving aid from the "Manual of Assaying," as well as your "Select Methods of Chemical Analysis?"—Geo. A. Marsh, Assayer for Pennsylvania Lead Co., Mansfield Valley, Allegheny County, Penn., U.S.A., Nov. 19th, 1888.

MEETINGS FOR THE WEEK.

Tuesday, Jan. 1st.—Pathological, 8.30. (Anniversary).
— Royal Institution, 3. "Clouds and Cloudland." by Professor Dewar, M.A., F.R.S.
Thursday, 3rd.—Royal Institution, 3. "Clouds and Cloudland," by Professor Dewar. M.A., F.R.S.
Friday. 4th.—Geologists' Association, 8.
Saturday, 5th.—Royal Institution, 3. "Clouds and Cloudland," by Professor Dewar, M.A., F.R.S.

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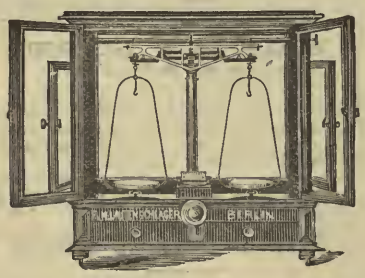

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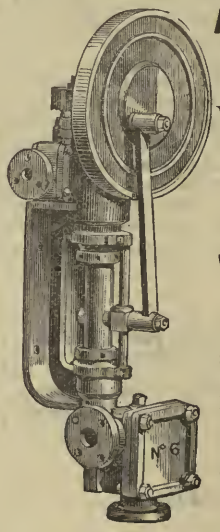

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INDEX.

ABERDEEN, University of, 149
Abney, W. de W., photometry of colours, 10
measurement of the luminosity of coloured surfaces, 265
Absorption-tube, modified, 166
Acetamide and phenanthraquinone, 241
Acetanilide, detection of phenacetine, 257
Acetic acid in acetates, determination of, 60
Acetone, quantitative determination of, 84
Acetones, new method of preparing, 281
Acid, acetic, in acetates, determination of, 60
amido-butyric, formation of, 231
boracic, volumetric estimation of, 175
carbonic, in solution, determining, 298
hydriodic, action of on allyl iodide, 220
hydrochloric, action, 232
malonic, neutralisation of, 72
peculiar reaction of, 49
molybdic, 85
volumetric determination of, 61
morrhuic, 256
nitric, action of, 263
in wine, determination, 84, 133
nitrous, tests, 40
oxalic, action of, 12
phosphoric, 280
in basic slags, determination of, 108
volumetric determination of, 61, 85, 184
pimelic, 48
salicylic, 256
succinic, action of ethylene diamine on, 241
solution, absorption of ammonia by, 6
sulphates of dimethyl-aniline and diphenylamine, 268
sulphuric, volumetric determination of, 72
sulphurous, and iodometry, 49
tartaric, improved method for the analysis of materials containing, 37
synthetic formation of toluyl-propionic, 25
Acidimetry and alkalimetry indicators, 49
Acids, aspartic, 12, 244
Acids, chlorofumaric and chloromaleic, 21
fatty, in soaps, 60
solubility of, 133
metaxylene-sulphonic, 21
organic, action of certain, 25
separation and determination, 220
toluen-sulphonic, 21
volumetric determination of, 293
Adams, M. A., milk, 49
Address to students, 135
Agricultural College, Cirencester, Royal, 141
"Agriculture, Report of the Commissioner, Washington" (review), 181
Air, combustion of in coal-gas, apparatus for showing, 55
detection of micro-organisms in, 97
moist, absorption of watery vapour from by solids, 197
Air-pump, modified mercurial, 84
Albertoni, P., detection of alcohol, 184
Albumen in urine, determination of, 245
Albumenoids, precipitation by salts, 184
Alchemists, Greek, collection of, 280
Alcohol, detection of, 184
indirect determination of, 184
methylic detection, 256
Alcoholic fermentation, product of, 12
solutions, vapour tensions, 132
Aldehyd, detection of, 208
Alpe, E. N., "Handy Book of Medicine Stamp Duty" (review), 254
Aliamet, M., new reagent for salts of copper, 184
Alkali, crude, purification of, 185
"Alkali Works Regulation Act, 1881" (review), 46
Alkaloid, volatile, in pepper, 235
Alkaloids, 24
of cod-liver oil, 48
Alkarsin, 268
Allary, E., chlorine and cyanogen, 60
compound nature of the elements, 220
Allen, A. H., brown oil, 170
Allen, G., "Force and Energy" (review), 280
Allyl ammonium, preparation of, 221
iodide, action of hydriodic acid on, 220
Alum baking-powders, experiments on, 276, 284
Alums, crystalline water of, 220
Alumina and glucina, separation of, 49
estimation of, 24
"Alumni Association Report" (review), 182
Aluminium and its alloys, relative value of to the arts, 227
chloride vapour, density and molecular weight of, 24
compounds, molecular weights of, 293
estimating with sodium thiosulphate, 109
manufacture, Castner's process, 64
Amagat, E. H., compressibility of gaseous oxygen, hydrogen, &c., 183
Ammonia absorption by acid solution, 6
action on some tungsten compounds, 289
combustion of oxygen in, 27
action of on metallic magnesium, 297
Amorphous antimony, 108
Anagyrine, 72
Analyses of fertilisers, 172, 195, 206
of two moneys, 164
simplification of the calculation of, 197
starch paste in volumetric, 245
Analysis, decomposition of silicates for, 310
in the dry way, excellent reduction agent for, 207
new method of chemical, 285
of ferro-aluminium, 11
of a mixture of silver chloride, cyanide, &c., 232
of brewer's yeast, 256
of materials containing tartaric acid, improved method, 37
of natural silicates, 182
of nickel silver, 48
of nitrogen chloride, 196
of soils, 196
of the water of the Nile, 71
"Analysis of Iron, Chemical" (review), 181
"Analysis, Outlines of Qualitative" (review), 219
Analytical methods, new, 161
notes on, 90
"Analyst, Public, Report for St. George's, Hanover Square" (review), 254
"Analyst, Public, Report for Kensington" (review), 255
"Analyst's Laboratory Companion" (review), 181
André, G., and M. Berthelot, nitrogen in vegetable soils, 71, 293
Aniline, action on epichlorhydrine, 72
in urine, detection of, 61
Animal fluids, reaction of, 61
Anthraquinone, probable orthoquinone from, 54
Antifebrine, antipyrine, and saccharine, tests for so-called, 51
Antimony, amorphous, 108
and bismuth, determination of small quantities of, 49
hydrochlorates of, 20
in minerals, detection of, 296
trichloride, &c., hydrochlorates of, 244
Antipyrine, antifebrine, and saccharine, tests for so-called, 51
Antiseptics, new, 132
Armstrong, H. E., and W. P. Wynne, constitution of the dichloronaphthalenes, 264
criteria of plane and axial symmetry, 240
Arnaud, A., active crystalline matter of the poisoned arrows of the Somalis, 25
M., elementary composition of crystalline strophantine, 59
Arnold, J. O., and H. J. Hardy, estimation of sulphur in steel, 41, 70
Aromatic bases, general reaction of the acid sulphates of some, 72
monamines, 12, 244
series, synthesis of seleniuretted compounds of, 244
Arrows, poisoned, of the Somalis, 25
Arsenic, allotropic, 268
antimony, and tin, separating, 96
in pyrites, determination of, 49
in the home, 189, 206
in tissues, determination of traces, 128
Arth, G., pimelic acid, 48
Arts, Society of, 233
Asbestos in filtration, use of, 48
"Asclepiad" (review), 316
Ash determination, 256
Ashes, new method of determining, 62
Aspartic acids, 12, 244
Association, Australian, for the Advancement of Science, 118, 201, 211, 230, 254

Association, British, 95, 111, 123, 133
Atomic weight of copper, 55
of gold, 257
weights of copper and silver, relation of, 69
standard of, 307
Atoms, chemical, definition of, 309
Auger, V., chlorides of the bibasic acids, 25
Austen, W. C. R., curious properties of metals and alloys, 235
Australian Association for the Advancement of Science, 118, 201, 211, 230, 254

BAILEY, G. H., and G. J. Fowler, halogen hydrides, 22
Banks, A. J., new laboratory drying oven, 54
Barillot, E., and P. Chastaing, sanitation of towns, 36
Barium and strontium, separation of calcium from, 60
ferrate, decomposition of, 12
sulphite, 128, 155
Barometer, new 11
Battendorff, A., detection of sodium phosphates, 48
Baubigny, M., separation of cobalt and nickel, 244
Baumann, A., analysis of soils, 196
Beaumentz, D., saccharine, 184
Béchamp, A., nature of milk, 268
Becquerel, E., preparation of phosphorescent strontium and calcium sulphides, 305
Beer, fusel oil in, 81, 87
Béhal, A., hydration of tolane, 24
silver nitrate, 24
Belfast, Queen's College, 146
Benzene, constitution of, 239
Benzidine hydrochlorates, 280
Benzoic aldehyd, decomposing action of, 303
with the polyatomic alcohols, combination of, 232
Berberine, 288
Bernheim, J., and G. Rousseau, certain hydrates of potassium ferrite crystallised in the dry way, 71
decomposition of barium ferrate, 12
Berthelot, M., and G. André, nitrogen in vegetable soils, 71, 96, 293
the collection of the ancient Greek alchemists, 280
Bertschinger, A., fatty acids in soaps, 60
Bevan, E. J., and C. F. Cross, action of chlorine on the ligno-celluloses, 215
combustion by means of chromic anhydride, 21
new compounds of magnesia with the halogens, 240
Binder, O., quantities of lime and soda for softening water, 84
Birkbeck Literary and Scientific Institution, 147
Birmingham, Mason Science College, 140
Bismuth and antimony, determination of small quantities of, 49
hydrochlorates of, 20
and lead, separation of, 129
characteristic reaction of, 221
in metallic iron and slags, detection of, 27
Blair, A. A., "Chemical Analysis of Iron" (review), 181
Blakesley, T. H., new barometer, 11
systems of scientific units of measurement, 291
Bleaching, dyeing, and tissue printing improvements, 161
Blende, hexagonal phosphorescent, 47
Blood, spectroscopic detection of, 37
stains, chemico-legal detection of, 208
Blount, B., new test for iron, 195
Blowpipe, working glass with, 184
Blümcke, A., resistance of materials to frost, 257
Blum, L., determination of ferric oxide in iron ores, 72
of sulphur in coke, 65
Blythe, G. W., alkarsin, 268
Bockdiry, P., researches on the falsifications of butter, 11, 12
Bodies, latent colours of, 232
Boilers, steam, water supply to, 273
Bolton, H. C., list of elementary substances announced from 1877 to 1887, 188
Bomb, calorimetric, 284
Boneko, F., detection of sulphuretted hydrogen, 208
Boracic acid, volumetric estimation of, 175
Borgmann, E., detection of nitric acid in wines, 84
examination of powdered spices, 48
Börnstein, E., detection of Fahlberg's saccharine in food, 72
Bornträger, J., salicylic acid, 256
Boron, preparation of, 283
Bott, W., new method of determining vapour-densities, 288
and J. B. Miller, new colouring-matters of pyrocresol, 288
Bouchardat, G., and J. Lafont, transformation of terpilene into menthene, 304
Bourgeois, L., artificial reproduction of hydro-cerussite, 220
Bowler, T. J., Chinese treatment of cobalt ores, 100
Bradford Technical College, 141
Bragard, M., quantitative determination of zinc, 84
Braithwaite, J., "Retrospect of Medicine" (review), 35
Bramwell, F., address to British Association, 111
Brandies, composition of, 244
Brasse, C., determination of mercury, 184
Brauner, B., standard of atomic weights, 307
and F. Tomicek, action of sulphuretted hydrogen on arsenic acid, 208
Bread and grain, study of, 132
Bréal, E., fixation of nitrogen by certain plants, 96
Bristol, University College, 140
British Association, 95, 111, 123, 133
Bromine and iodine, toxicological detection of, 208
and selenium, limit of refraction, 252
in sea-water, determination of, 190
versus chlorine for gold extraction, 92
Brown oil, 161, 170
Brücke, E., use of congo-red in the reaction of urine, 208
Brunnemann, C., determination of phosphoric acid in basic slags, 108
Buchan, A., analysis of fertilisers, 195
Buisine, A. and P., alleged reagent for the copper salts, 293
Bumping ebullition, 235
Burbank, J. C. B., photography of the solar spectrum, 311
Burcker, E., synthetic formation of toluyl-propionic acid, 25
Burfeind, W. H., bromine versus chlorine for gold extraction, 92
Butter falsifications, 11, 12

CALCIUM and strontium sulphides, preparation of, 305
Calcium from barium and strontium, separation, 60
Calorimeter, industrial value of Thompson's, 37
Calorimetric bomb, the, 284
Cambridge University 136
Camphorates, nitro-, 12
Carbohydrate capable of fermentation, 13
Carbon, a property of, 24
from pig-iron, steel, &c., new mixture for separating, 199
oxysulphide, production of, 305
Carbonic acid in solution, new method of determining, 298
Carnelley, T., and A. Thomson, solubility of isomeric organic compounds, 22
Carnot, A., determination of lithium in mineral waters, 83
new method of determining lithium, 71
use of hydrogen peroxide for determining metals of the iron group, 316
Cassal, C. E., "Report of Public Analyst of St. George's, Hanover Square" (review), 254
Castner's process for the manufacture of aluminium, 64
Catalysis of potassium chlorate and manganese dioxide, 247
Caventon, E., and C. Girard, action of oxalic acid, 12
Cazeneuve, P., nitro-camphorates, 12
and M. Hugounenq, pretended reaction for phloroglucine, 24
determination of nitrogen, 183
Central School of Chemistry, New, 148
Cerite metals, certain compounds of, 36
Cerium salt of chinoline, 199
Chabrié, M. C., synthesis of seleniuretted organic compounds in the aromatic series, 244
Chappuis, J., and G. Maneuvrier, electrolysis, 12
Charterhouse Science and Art Schools, 148
Chastaing, P., and E. Barillot, sanitation of towns, 36
"Chemical Action and Affinity, Correlation Theory" (review), 315
analysis, new method of, 285
"Chemical Analysis of Iron" (review), 181
"Chemical and Physical Apparatus, Catalogue" (review), 292
atoms, definition of, 309
change, gradual, investigation of, 308
character of the peptones, 183
Education, Central Institution, 121
examination of certain gums and resins, 224
laboratories and class-rooms, 149
"Chemical Laboratory Labels" (review), 254
Laboratory of Wiesbaden, 121
lectures at London hospitals, 148
classes, and laboratory instruction, 147
literature, report of committee for indexing, 200
"Chemical Notes and Equations for Students" (review), 230
phenomena, mathematical investigation of, 47
reactions, Liebreich's dead space in, 297
Section of British Association, address, 123
Society, 21, 239, 262, 287
test for cholera bacteria, 60
Chemico-legal detection of blood-stains, 208
"Chemistry and Physics, Application of Dynamics to" (review), 36
"Chemistry, Class-book of Elementary" (review), 219
Chemistry, College of, Liverpool, 142
Chemistry, foundations of, 193, 204, 212
"Chemistry, Laboratory Manual of General" (review), 253
"Chemistry, Modern, Theories and Notations of" (review), 231
"Chemistry, New Course of Experimental" (review), 267
report on present methods of teaching, 157, 167
schools, 136
Chemists, a warning, 255
Chinese treatment of cobalt ores, 100
Chinoline, cerium salt of, 199
Chloral, direct detection of, 257
Chlorate of potassium, 309
"Chlorates, Manufacture of" (review), 57
Chloride, determination of sodium, 172
of sulphur on oils, action of, 4
Chlorides, chromium, 183
of gallium, 183
indium, 183
of the bibasic acids, 25
Chlorine, action of, 12
action on the ligno-celluloses 215
and cyanogen, 60
density of, 83
determination of, 281
on metallic gold, action of, 25
volumetric determination of, 229
Chlorofumaric and chloromaleic acids, 21
Chlorothiocyanate, mercuric, 290
Cholera bacteria, chemical test for, 60
Chromic anhydride, combustion by means of, 21
Chromium chlorides, 183
compounds, 23
oxychloride on pinene, action of, 290
Church, A. H., "The Laboratory Guide" (review), 57
Chydrazine, 59
Cinchonine, optical isomers of, 59
Cinnamyl - diethacetate, ethylic, 263
Circle, helix and coaxal, calculation of the coefficient of mutual induction, 252
Cirencester, Royal Agricultural College, 141
City and Guilds of London Institute, 147
City School of Chemistry, 148
Claesson, P., determination of sulphur, 96
Claudon, E., and E. C. Morin, products of the alcoholic fermentation, 12
Clemence, A. B., use of cotton as a filter, 178
Coal-gas, apparatus for showing combustion of air in atmosphere of, 55
Coal-tar naphtha, adulteration of, 235, 247
Cobalt and nickel, separation of, 244
from iron, separation of, 208
chloride hydrochlorate, 36, 59
Coca, erythroxylon, grown in India, note o , 249, 260, 273
Cod-liver oil, alkaloids, 48
Coil, new form of standard resistance, 253
Coke and graphite, incineration of, 197
determination of sulphur in, 65
Cobalt ores, Chinese treatment of, 100
Colleges and Universities, 135
Collie, N., mixed tertiary phosphines, 22
Colloidal state, 25
Collins, John, Obituary, 266
Colman, H. G., derivatives of methylindole, 241
Coloriano, A , crystalline metallic molybdates. 293
Colour, photometry of, 10
Colours of bodies, latent, 232

Coloured surfaces, measurement of the luminosity, 265
Colouring-matters, action of micro-organisms on, 132
fixed on tissues, resistance to light, 60
Combes, A., action of phenylhydrazine, 244
Condenser attachment, new, 79
Congo-red, use in the reaction of urine, 208
Contact action, dissociation by, 153
Cook, E. H., undulatory movement accompanying the electric spark, 11
Cooke, J. P., and T. W. Richards, relative values of the weights of hydrogen and oxygen, 7, 17, 30, 52
Cooke, S., action of electric sparks on mixtures of nitric oxide, 130
decomposition of nitric oxide, 155
reducing action of hydrogen in presence of palladium, 103
Cooper, W. J., glazes for earthenware, 257
Copper and silver, atomic weights, relation of, 69
atomic weight of, 55
determination of, 272
estimation of, 131
reds, 25
salts, alleged reagent for the, 293
new reagent for, 184
smelting, American method, 76, 108, 131
Cork, Queen's College, 147
Cotton as a filter, use of, 178
Courtonne, M., determination of dry matter in syrups, &c., 256
Crafts, J. M., purification of mercury, 60
remarks on the observations of M. Maumené, 220
and C. Friedel, density of chlorine, &c., 83
vapour-density and molecular weight of aluminium chloride, 24
Craig, G., apparatus for showing combustion of air in atmosphere of coal-gas, 55
"Cramming, Essay on" (review), 267
Cream and milk, determination of fat in, 197
Creoline, 132
Crookes, W., award of the Davy Medal of the Royal Society to, 279, 301

DE LA HARPE, C., and F. Reverdin, determination of para-nitro-toluene, 220
nitro-nitroso-resorcine, 59
Denigés, G., action of sodium hypobromite, 232
Dewar, J., and M. Liveing, absorption-spectrum of oxygen, 163
Dialysis, electrical, 76
Dichloronaphthalenes, constitution of, 264
Dickson, E., analysis of natural silicates, 182
Dietrich, E., limited sensitiveness of indicators, 196
Diketones, condensations of, 289
Dioxide, sulphur, apparatus, 187
Discoveries and inventions, rewards for, 243
"Dispensing, the Art of" (review), 304
Dissolution, heat of, of various substances in different liquids, 240
Distiller's guide-book, 182
Dry matter in syrups, &c., determination of, 256
Drying apparatus, 207
Dublin University, 136
Duboin, A., certain double yttrium and potassium or sodium phosphates, 232
Dubois, A., certain compounds of yttrium, 48
decolouration of tincture of litmus in closed vessels, 219
Dunnington, F. P., formation of deposits of oxide of manganese, 312
Dunstan, W. R., and T. S. Dymond, decomposition of nitroethane, 290
Durham College of Science, Newcastle-on-Tyne, 143
Dutailly, G., and C. Lauth, copper reds, 25
covering shell of hard porcelain, 25
Dye, a seaweed, 15
"Dyeing" (review), 242
tissue printing, and bleaching improvements, 161
Dymond, T. S., and W. R. Dunstan, decomposition of nitroethane, 290
"Dynamics to Physics and Chemistry, Application of" (review), 36

EARRINGS, 257
Earth-nut oil, sensibility to heat when electrified, 259
Earths, rare, which produce absorption-spectra, 75, 91
Earthenware, glazes for, 257
Edinburgh University, 145
Education, chemical, Central Institution, 121
Eggertz's carbon colour-test, influence of sulphur on, 175
Eiloart, A., the calorimetric bomb, 284
Eissler, M., "Metallurgy of Gold" (review), 253
Electric spark, undulatory movement accompanying the, 11
Electric spark on mixtures of nitric oxide, action of, 130
Electrical dialysis, 76
Electrician's directory and handbook for 1889, 292
"Electricity for Public Schools and Colleges" (review), 35
Electrified, sensibility of earth-nut oil to heat when, 259
Electrolysis, 12
Electrolytes, influence of the chemical energy of 3, 15
Electrolytic method of liquefying gases, 127
Electro-magnetic capacity, determining, 291
Elements, compound nature of, 220
ultra violet spectra of, 204
Elementary substances announced from 1877 to 1887, 188
Emerald and phenacite, artificial production, 24
Enamel, infusible blue-black, 25
Endothermic reactions, application of Carnot's principle to, 36
Engel, M., action of hydrochloric acid, 232
allotropic arsenic, 268
aspartic acids, 12
formation of amido-butyric acid, 231
hydrochlorates of antimony and bismuth, 20
trichloride, &c., 244
observations on P. Sabatier's hydrochloric copper chloride, 59
Epichlorhydrine, action of aniline on, 72
"Equations and Chemical Notes for Students" (review), 230
Ether, cyanacetic, synthesis by means of, 48
Ethylene cyanide, preparation of, 268
diamine, action on succinic acid, 241
Ethyl fluoride, 72
Ethylic cinnamyl diethacetate, 263
Evans, J. C., "New Course of Experimental Chemistry" (review), 267
Extracts, examination of, 109

FAHLBERG'S saccharine in food, detection of, 72
Fat in milk and cream, determination of, 197
Fatty matter in linseed cake, determination of, 196
Fauconnier, A., action of aniline on epichlorhydrine, 72
preparation of ethylene cyanide, 268
Ferric oxide, determination, 72
Ferriferous lime, fluorescence of, 12
Ferro-aluminium, analysis of, 11
Ferrous chloride, 183
Fertilisers, analyses of, 172, 195
Filter, use of cotton as, 178
Filters of metallic felt, 101
Firby, A., analyses of fertilisers, 172, 206
Firth College, Sheffield, 144
Fisher, W. W., "Class-book of Elementary Chemistry" (review), 219
Fleming, J. A., new form of standard resistance coil, 253
Fletcher, L., meteoric irons, 106, 119
Flückiger, F. A., determination of ash, 256
Food, detection of Fahlberg's saccharine, 72
"Force and Energy" (review), 280
Formic acid, action on the terebenthenes, 11
Fowler, G. J., and G. H. Bailey, halogen hydrides, 22
Fox, W., action of petroleum on lead, 39
French technical terms, 11
Fresenius, H., determination of arsenic in pyrites, 49
Fresenius, W., use of asbestos in filtration, 48
Fresenius, R., and E. Hintz, determination of traces of arsenic in tissues, 128
Friedel, C., and J. M. Crafts, density of chlorine, &c., 83
vapour-density and molecular weight of aluminium chloride, 24
Frost, resistance of materials to, 257
Frühling, R., and V. Gerlach, new antiseptics, 132
Furfurol, detection of, 49
Fusel in spirits, detection of, 60
oil in beer, 81, 87

GADOLINITE from Hitterö, 91
Gallium chlorides, 183
perchloride, vapour-density of, 83
Gallois, N., and E. Hardy, anagyrine, 72
Gas balance, the, 4
quantity of moisture which remains in after desiccation by phosphorus pentoxide, 37
"Gas-works Statistics" (review), 160
Gases, absorption of, 256
electrolytic method of liquefying, 127
occlusion of, 255
specific heats at constant volume, 271
Gastine, M., starch-paste in volumetric analyses, 245
Gattermann, M., analysis of nitrogen chloride, 196
Gautier, A., production of carbon oxysulphide, 305
and L. Mourgues, alkaloids of cod-liver oil, 48
morrhuic acid, 256
Gawalowski, A., volumetric determination of sulphuric acid, 72
Geisler, J. F., new condenser attachment, 79
Gerlach, V., and R. Frühling, new antiseptics, 132
Gillet, M., falsification of pepper with olive kernels, 245
Girard, C., saccharine, 196
and E. Caventon, action of oxalic acid, 12
Glasgow and West of Scotland Technical College, 145
Glass in polarised light, experiments on, 253
working with the blowpipe, 184
Glucina and alumina, separation of, 49
siliceous compounds of, 268
Gluetina, 50
Glycerin, 293
by oxidation, determination of, 71
determination, 208
Gniewosz, S., and A. Walfiscz, absorption of gases by petroleum, 256
Gold, atomic weight of, 257
and platinum, separation from arsenic, &c., 172
extraction, bromine versus chlorine for, 92
metallic action of chlorine on, 25
quantitative determination of, 49
"Gold, Metallurgy of" (review), 253
Gordon, H., formation of isomeric toluen sulphonic acids, 21
Gore, G., influence of the chemical energy of electrolytes, 3, 15, 51
voltaic balance, 64
Gorgen, A., action of roasting on various oxides and salts of manganese, 36
Govi, G., latent colours of bodies, 232
Grain and bread, study of, 132
Graphite and coke, incineration of, 197
Greek alchemists, collection of ancient, 280
Green, A. G., isomeric sulphonic acids, 263
Griess, Peter, obituary, 131
Grimaux, E., on a carbohydrate capable of fermentation, 13
Grimbert, L., and M. Jungfleisch, levulose, 96
Grünwald, A., definition of chemical atoms, 309
Gums, 25
and resins, chemical examination of certain, 224
Gutzkow, F., determination of bromine in sea water, 190

HABERMANN, J., detection of methylic alcohol, 256
Hall, T. W., "Correlation Theory of Chemical Action and Affinity" (review), 315
Haller, A., synthesis by means of cyanacetic ether, 48
Halogen hydrides, 22
magnesia compounds with, 240
Hamlet, W. M., fusel oil in beers, 81, 87
"Handbook of Australian Association for the Advancement of Science" (review), 254
Hamonet, M. J., new method of preparing acetones, 281
Hardy, E., and N. Gallois, anagyrine, 72
H. J., and J. O. Arnold, estimation of sulphur in steel and steel-making iron, 41, 70
Hartley, W. N., ultra violet spectra of the elements, 304
Hastings, C. W., "Gas Works' Statistics" (review), 160
"Water Works' Statistics" (review), 160
Haughton, S., geometrical illustrations of the periodic law, 93, 102

Hautefeuille, P., and A. Perrey, artificial production of phenacite and emerald, 24
siliceous compounds of glucina, 268
Hawliczek, J., and T. T. Mathieson, purification of crude alkali, 185
Haynes, I. S., absorption of ammonia by acid solution, 6
Heat of dissolution of various substances in different liquids, 240
Henderson, G. G., and R. W. Smith, action of chromium oxychloride on pinene, 290
Hérard, F., amorphous antimony, 108
Herzog, H., Jun., separation of lead and bismuth, 129
Hintz, E., quantitative determination of acetone, 84
and R. Fresenius, determination of traces of arsenic in tissues, 128
Hirn, G. A., a property of carbon, 24
Hodges, E. R., barium sulphite, 128
new form of sulphur dioxide apparatus, 187
Hodgkinson, W. R., and F. K. S. Lowndes, action of a platinum wire made incandescent, 223
action of incandescent platinum wire on gases and vapours, 187, 223
combustion of oxygen in ammonia, 27
potassium chlorate, 309
Hogg, T. W., influence of sulphur on Eggertz's carbon colour-test, 175
new mixture for separating carbon from pig-iron, steel, &c., 199
Hoffmann, L., and G. Krüss, quantitative determination of gold, 49
Honey, examination of, 97
Horn, F. M., oil of the seeds of jatropha curcas, 72
Houston, E. J., palladium alloys in watches, 100
Hugounenq, M., and M. Cazeneuve, determination of nitrogen, 183
pretended reaction for phloroglucine, 24
L., and Morel, J., new double potassium and sodium carbonate, 53
Hunt, T. S., classification and nomenclature of metalline minerals, 66, 79
dissociation in fused metallic sulphides, 87
foundations of chemistry, 193, 204, 212
mineralogical evolution, 180
theory of solution, 151
the study of mineralogy, 178
Hydrates, methane and ethylene, 96
Hydration of tolane, 24
Hydride, silicon, 215
Hydriodic acid, action of on allyl iodide, 220
Hydrocarbons with rock salt, curious association in nature, 87
Hydro-cerussite, artificial reproduction, 220
Hydrochlorate, cobalt chloride, 36, 59
Hydrochlorate of cupric chloride, 220, 245
Hydrochlorates of antimony trichloride, 244
Hydrochloric acid, action, 232
Hydrogen and oxygen, relative values of the weights of, 7, 17, 30, 52
oxygen, &c., compressibility of gaseous, 183
peroxide, use of, 316
reducing action in presence of palladium, 103
Hydrogen sulphide, action of, 256
in urine, detection, 160
sulphuretted, cheap apparatus for generating, 99, 123
detection of, 208
on arsenic acid, action of, 208
Hypobromite, sodium, action of, 232

IHMORI, T., absorption of watery vapour from moist air by solids, 197
Indexing chemical literature, report of committee, 200
Indicators, limited sensitiveness of, 196
Indican, detection of, 109
Indium chlorides, 183
"Indium Chlorides, Two New" (review), 292
Infirmary Medical School, 149
Institute of Chemical Technology, 148
Institution, Royal, 24, 257, 281, 305
Inventions and discoveries, rewards for, 243
Iodide propylene, production of, 268, 293
transformation of, 48
Iodine and bromine, toxicological detection of, 208
Iodometric determinations, influence of organic bodies on, 197
Iodometry and sulphurous acid, 49
Iodophenols, 36
Iron and nickel, crystalline subsulphide of, 200
"Iron, Chemical Analysis of" (review), 181
Iron, new test for, 178, 195
Iron and steel, determination of sulphur in, 63, 71, 95
Iron and steel, determination of phosphorus in, 165
separation of nickel and cobalt from, 208
steel-making, estimation of sulphur in steel and, 41, 59, 95
sulphur in, 255
titration of, 156
Irons, meteoric, 106, 119
Irving, A., ancient mortars, 219, 243
dissociation by contact-action, 153
Ireland, Royal College of Science, 147
Isomeric naphthalene derivatives, 295
sulphonic acids, 263

JACQUEMIN, G., saccharomyces ellipsoideus, 36
Janssen, M., spectrum of oxygen, 244
Japp, F. R., and F. Klingemann, condensation of diketones, 289
Joannis, A., modified mercurial air-pump, 84
Joffre, J., resistance to light of colouring-matters fixed on tissues, 60
Johnson, A. E., "Analyst's Laboratory Companion" (review), 181
new wash-bottle, 182
Johnson, G. S., solubility of barium sulphite, 155
Johnstone, A., decomposition of silicates for analysis, 310
Johnstone, A., detection of antimony in minerals, 296
Johnstone, W., volatile alkaloid in pepper, 235
Joly, J., specific heats of gases at constant volume, 271
Jones, J. V., calculation of the coefficient of mutual induction of a helix and coaxal circle, 252
Julian, F., determination of manganese in steels, 209
Julius, P., improvements in dyeing, tissue-printing, and bleaching during second half of 1887, 161
Jungfer, P., determination of small quantities of bismuth and antimony in commercial copper, 49
Jungfleisch, E., and E. Léger, optical isomers of cinchonine, 59
and L. Grimbert, levulose, 96
Jurisch, K. W., "Manufacture of Potassium Chlorate and other Chlorates" (review), 57

KAYSER, K., examination of honey, 97
Kehrmann, F., determination of phosphoric acid, 184
Kerner's method for estimating quinine, 202, 216, 226
Kestner, M. S., industrial value of Thompson's calorimeter, 37
Keyworth, G. A., cleansing stone and waterproofing, 245
Kiesewetter, P., and G. Krüss, rare earths which produce absorption-spectra, 75, 91
King's College, 137
Metallurgical Department, 185
Kjeldahl's determination of nitrogen, 49
Klaudie, J., influence of organic bodies on iodometric determinations, 197
Kleemann, S., peculiar reactions of malonic acid, 49
Klingemann, F., and F. R. Japp, condensations of diketones, 289
Klopsch, R., determination of fatty matter in linseed cake, 196
Krüss, G., and L. Hoffmann, quantitative determination of gold, 49
and P. Kiesewetter, rare earths which produce absorption-spectra, 75, 91
Kupfferschlæger, M., separation of calcium from barium and strontium, 60

LABORATORY drying oven, new, 54
"Laboratory Guide" (review), 57
instruction and chemical lectures and classes, 147
Lafont, J., action of crystalline formic acid on the terebenthenes, 11
and G. Bouchardat, transformation of terpilene into menthene, 304
Larden, W., "Electricity for Public Schools and Colleges" (review), 35
Lauth, C., infusible blue-black enamel, 25
and G. Dutailly, copper reds, 25
covering shell of hard porcelain, 25
Lead, action of petroleum on, 39
and bismuth, separation of, 129
extraction from the residues of the production of zinc, 37
in tin alloys, determination of, 109
volumetric determination of, 61
Le Bel, J. A., mineral matter in natural petroleums, 293
Lecrenier, A., and M. de Koninck, separation of gold and platinum from arsenic, antimony, and tin, 172
Leger, E., characteristic reaction of bismuth, 221
and E. Jungfleisch optical isomers of cinchonine, 59
Legler, L., determination of glycerin, 208
Leidié, E., salts of rhodium, 71
Lescœur, M., and M. Mathurin, crystalline water of the alums, 220
Lesser, E., separating arsenic, antimony, and tin, 96
Levulose, 96
Levy, L., four new zinc titanates, 108
Lewith, S., precipitation of albu-
Lewy, L., behaviour of toluidine with phosphoric acid, 184
menoids by salts, 184
Liebreich's dead space in chemical reactions, 297
Light, influence on the explosion of nitrogen iodide, 64
polarised, experiments on glass in, 253
resistance to, of colouring-matters fixed on tissues, 60
ultra violet, selective absorption of metals for, 216
Ligno-celluloses, action of chlorine on, 215
Lignon, M., and G. Linossier, determination of chlorine, 281
Lime, ferriferous, fluorescence of, 12
Lindet, M., action of chlorine on metallic gold, 25
Lindo, D., phenol and some allied bodies, 1, 15, 28
resorcinol as a test for nitrates, 176
tests for nitrous acid, 40
for so-called saccharine, antipyrine, and antifebrine, 51, 155
Linossier, G., determination of phosphoric acid, 280
separation and determination of acids, 220
spectroscopic detection of blood, 37
and M. Lignon, determination of chlorine, 281
Linseed cake, determination of fatty matter in, 196
Liqueurs, &c., determination of sugar in, 196
Lithium in metallic iron and slags, detection of, 27
mineral waters, determination of, 83
new method of determining, 71
Litmus, tincture of, decolouration in closed vessels, 219
Liveing, M., and J. Dewar, absorption spectrum of oxygen, 163
Liverpool College of Chemistry, 142
University College, 142
London University, 135
water-supply, 46, 91, 176, 195, 252, 310
Long, J. H., circular polarisation of certain tartrate solutions, 313
Lowndes, F. K. S., and W. R. Hodgkinson, action of a platinum wire made incandescent, 223
incandescent platinum wire on gases and vapours, 187, 223
combustion of oxygen in ammonia, 27
potassium chlorate, 309
Lorenz, N., improved method for the analysis of materials containing tartaric acid, 37
waterproofing, 233
Lorin, M., action of certain organic acids, 25
Louise, E., and M. Roux, molecular weights of the aluminium compounds, 293
Luke, D. L., influence of manganese sulphate on the titration of iron, 156
Lunge, G., detection of nitrogen compounds, 184
preparation of soda, 132
Lupton, S., compounds of chromium, 23
Lyte, F. M., curious association of hydrocarbons with rock-salt in nature, 87

MACKINTOSH, J. B., crystalline subsulphide of iron and nickel, 200
separation of nickel and cobalt from iron, 208
McCay, Le R. W., action of hydrogen sulphide, 256
McGlashan, J. volumetric estimation of boracic acid, 175
McMurtry, G. C., thionyl thiocyanate, 290
Magnesia compounds with the halogens, 240
Magnesium, metallic action of ammonia on, 297
Malbot, H., action of hydriodic acid on allyl iodide, 220
preparation of the allyl ammoniums, 221
production of propylene iodide, 268, 293
transformation of propylene iodide, 48
Mallet, J. W., experiments on alum baking-powders, 276, 284
influence of light upon the explosion of nitrogen iodide, 64
Malonic acid, neutralisation of, 72
peculiar reaction of, 49
Malot, C., volumetric determination of phosphoric acid, 85
Manchester, Owen's College, 143
Maneuvrier, G., and J. Chappuis, electrolysis, 12
Manganese, action of roasting on various oxides and salts, 36
determination of, 173
dioxide, 247
in steels, determination of, 209
oxides, formation of deposits, 312
steel, 172
sulphate, on the titration of iron, influence, 156
Mannite, compounds of, 12
Maquenne, H., combination of benzoic aldehyd with the polyatomic alcohols, 232
Marcano, V., peptonic fermentation of meat, 48
yaraque, 256
and A. Müntz, black waters of the equatorial regions, 305
Marson, M., detection of sugar in urine, 109
Martin, J., cheap apparatus for generating sulphuretted hydrogen, 99
Martinand, M., analysis of brewers' yeast, 256
Martindale, W., "The Extra Pharmacopœia" (review), 160
Mason, A. T., acetamide and phenanthraquinone, 241
piazine derivatives, 265
Mason Science College, Birmingham, 140
"Massachusetts, Report of the State Board of Health" (review), 171
Massan, H., ethyl fluoride, 72
Massol, M., neutralisation of malonic acid, 72
Mathematical investigation of chemical phenomena, 47
Mathews, F. G., action of nitric acid, 263
Mathieson, T. T., and J. Hawliczek, purification of crude alkali, 185
Mathurin, M., and M. Lescœur, crystalline water of the alums, 220
Maumené, E. J., chydrazine, 59
M., remarks on the observations of, 220
Meat, peptonic fermentation of, 48
Mechanics' Institution, Sheffield, 149
"Medical References" (review), 160
"Medicine, Retrospect of" (review), 35
"Medicine Stamp Duty, Handy Book" (review), 254
Mercurial air-pump, modified, 84
Mercuric chlorothiocyanate, 290
Mercury determination, 184
purification of, 60
valve in place of glass and pinch-cocks, 256
Metals and alloys, curious properties of, 235
cerite, certain compounds of, 36
positive effect of different on changes of potential of voltaic couples, 51
selective absorption for ultra violet light, 216
Metallic felt filters, 101
lustre, 269
spectra in the ultra violet, wave lengths of, 237, 247, 304
sulphides, dissociation of fused, 87
Metalline minerals, classification and nomenclature of, 66, 79
Metallurgical department, King's College, 185
"Metallurgy of Gold" (review). 253
Metaxylene-sulphonic acids, 21
Meteoric irons, 106, 119
Methane and ethylene hydrates, 96
Methylic alcohol, detection of, 256
Methylindole, derivatives of, 241
Meunier, J., compounds of mannite, 12
decomposing action of benzoic aldehyd, 303
Meyer, L., transferrers of oxygen, 63
Michailow, M., detection of indican, 109
Micro-organisms in the air, detection of, 97
on colouring matters, action of, 132
Milk, 49
nature of, 268
Miller, J. B., and W. Bott, new colouring matters of pyrocresol, 288
Mineral matter in natural petroleums, 293
Minerals, detection of antimony, 296
metalline, classification and nomenclature of, 66, 79
the rarer, 73
Mineralogical evolution, 180
Mineralogy, study of, 178
Mines, Royal School of, 138
Molybdates, crystalline metallic, 293
Molybdic acid, 85
volumetric determination of, 61
Monamines, aromatic, 12, 244
Moneys, analyses of, 164
Monmouthshire and South Wales, University College, 139
Moody, G. T., metaxylene-sulphonic acids, 21
Morel, J., and L. Hugounenq, new double potassium and sodium carbonate, 53
Morgan, J. J., colorimetric determination of sulphur in iron and steel, 59, 63, 71
determination of sulphur in iron and steel, 63
Morin, E. C. and E. Claudon, products of the alcoholic fermentation, 12
Morley, E. W., quantity of moisture which remains in a gas after desiccation by phosphorus pentoxide, 37
Morphia in opium, detection of the amount, 27
Morrhuic acid, 256
Mortar, analysis of ancient from the Roman Wall, 189, 219, 231, 243
Mourgues, L., and A. Gautier, alkaloids of cod-liver oil, 48
morrhuic acid, 256
Mulhouse Industrial Society, 196
Müller, F., detection of aniline in urine, 61
detection of hydrogen sulphide in urine, 160
Mullins, W. J., brown oil, 161
Munroe, C. E., filtration with filters of metallic felt, 101
Müntz, A., analysis of the water of the Nile, 71
and V. Marcano, black waters of the equatorial regions, 305
Murch, W., solubility of fatty acids, 133
Murray, R. M., "Chemical Notes and Equations for Students" (review), 230

NAPHTHA, coal-tar, adulteration of, 235, 247
Naphthalene derivatives, isomeric, 295
Nelissen, F., excellent reduction agent for analysis in the dry way, 207
Nettlefold, F., a seaweed dye, 15
Newcastle-on-Tyne School of Science and Art, 149
Nickel and cobalt from iron, separation of, 208
separation of, 244
and iron, crystalline subsulphide of, 200
silver, analysis of, 48
Nile, analysis of the water, 71
Nilson, L. F., and O. Petterson, ferrous chloride and chromium chlorides, 183
gallium chlorides, 183
indium chlorides, 183
"Two New Indium Chlorides" (review), 292
Nitrate, silver, 24
Nitrates, resorcinol as a test for, 176
Nitric acid, action of, 263
in wines, detection of, 84, 133
oxide, action of electric sparks on mixtures of, 130
decomposition of, 155
Nitro-camphorates, 12
Nitro-ethane, decomposition of, 290
Nitro-nitroso-resorcine, 59
Nitrogen chloride, analysis of, 196
compounds, detection of, 184
determination of, 49, 183, 268
Kjeldahl's process for determining, 96
in vegetable soils, 71, 83, 96, 293
iodide explosion, influence of light on, 64
Nitrous acid tests, 40
Noelting, E., and T. Strecker, iodophenols, 36
Normal School of Science and Royal School of Mines, 138
Nottingham, University College, 144

OBITUARY, John Collins, 266
Jules Henri Debray, 70
Peter Griess, 131
Prof. Tuson, 230
Dr. Wallace, 266
Odling, W., W. Crookes, and C. M. Tidy, London water supply, 46, 91, 176, 195, 252, 310
Oettel, F., analysis of nickel silver, 48
Oil, brown, 161, 170
cake, valuation of, 211
casks, 209
cod-liver, alkaloids, 48
earth-nut, sensibility to heat, 259
fusel, in beer, 81, 87
of the seeds of Atropha curcas, 72
Oils, action of sulphur chloride on, 4
new method of examining mixtures, 15
Onslow College of Science, 148
Opium, detection of the amount of morphia in, 27
Optical model, an, 10
Organic bodies, influence on iodometric determinations, 197
compounds, solubility of isomeric, 22
matter, incineration of, 197
Orthoquinone from anthraquinone, probable, 54
Osborne, T. B., notes on analytical methods, 90
Ouvrard, M., certain compounds of the cerite metals, 36
L., new double phosphates in the magnesian series, 12
Oven, drying, for laboratory, 54
Oxford University, 136
Oxalic acid, action of, 12
Oxide, ferric, determination of, 72
nitric, decomposition of, 155
Oxides of manganese, formation of deposits of, 312
and salts of manganese, action of roasting on various, 36
Oxygen, absorption spectrum of, 163
and hydrogen, relative values of the weights of, 7, 17, 30, 52
estimation of, 269
formation of, 260
hydrogen, &c., compressibility of gaseous, 183
in ammonia, combustion of, 27
in quantity, generating pure, 207
spectrum, 244
transferrers, 63
Oxysulphide of carbon, production of, 305
Owens College, Manchester, 143

PALLADIUM alloys in watches, 100
reducing action of hydrogen in presence of, 103
Palm, R., chemical character of the peptones, 183
Papasogli, G., changes in the weight of bodies, 256
Para-nitrotoluene, determination of, 220
Paraphenylen-diamine, researches on, 244
Patein, G., sulphines, 37
Pellat, M., application of Carnot's principle to endothermic reactions, 36
Pemberton, H., Jun., relative value of aluminium and its alloys to the arts, 227
Pendlebury, W. H., and M. Seward, investigation of a case of gradual chemical change, 308
Pepper, falsification of, 245
volatile alkaloid in, 235
Peptonic fermentation of meat, 48
Peptones, chemical character of, 183
Periodic law, geometrical illustration of, 93, 102
Perkin, W. H., chlorofumaric and chloromaleic acids, 21
Perkin, W. H., Jun., berberine, 288
Permanganate of potassium, 269
Peroxide of hydrogen, use of, 316
Perry, A., and P. Hautefeuille, artificial production of phenacite and emerald, 24
siliceous compounds of glucina, 268
Peters's American methods of copper smelting, 76, 108, 131
Petit, P., benzidine, hydrochlorates, 280
Petri, R. J., detection of micro-organisms in the air, 97
Petroleum on lead, action of, 39
Petroleums, mineral matter in natural, 293

Petterson, O., and L. F. Nilson, ferrous chloride and chromium chlorides, 183
gallium chlorides, 183
indium chlorides, 183
"Two New Indium Chlorides" (review), 292
Pflüger, E., action of water-sprengel's 207
"Pharmacopœia, Extra" (review), 160
Phenacetine, detection in acetanilide, 257
Phenacite and emerald, artificial production, 24
Phenanthraquinone and acetamide, 241
Phenol and some allied bodies, 1, 15, 28
Phenylhydrazine, action of, 244
new salts of, 39
Phillips, C. W., new method of chemical analysis, 285
Phipson, T. L., rhinanthin, 99
Phloroglucine, pretended reaction for, 24
Phosphate, detection of sodium, 48
Phosphates, certain double yttrium and potassium or sodium, 232
new double, in the magnesian series, 12
Phosphines, mixed tertiary, 22
Phosphoric acid, 280
volumetric, determination of, 61, 85, 184
in basic slags, determination of, 108
Phosphorus and sulphur, dissemination of, 177
in iron and steel, determination of, 165
pentoxide, quantity of moisture which remains in a gas after desiccation by, 37
Photography of the solar spectrum, 311
Photometry of colour, 10
Physical quantities, suppressed dimensions of, 265
Society, 10, 252, 265, 291
"Physics and Chemistry, Application of Dynamics to" (review), 36
Piazine-derivatives, 265
Pickering, S. U., heat of dissolution of various substances in different liquids, 240
principles of thermo-chemistry, 262
Pig-iron, steel, &c., new mixture for separating carbon from, 199
Pimelic acid, 48
Pinene, action of chromium oxychloride, 290
Planchon, V., determination of glycerin by oxidation, 71
Plants, fixation of atmospheric nitrogen by certain, 96
Platinum and gold, separation from arsenic, &c., 172
wire, incandescent action on gases and vapours, 187, 223
made incandescent, action of, 223
Poisoned arrows, 25
Poisons and poisoning, 33, 44
Pollak, E., determination of nitric acid in wine, 133
Polyatomic alcohols, combination of benzoic aldehyd with, 232
Popow, M., study of grain and bread, 132
Porcelain, covering-shell of hard, 25
Portman School of Pharmacy, 148
Potassium, action of, 22
and sodium carbonate, new double, 53
chlorate, catalysis of, 247, 309
ferrite, certain hydrates of, crystallised in the dry way, 71
permanganate, 269
Potassium Chlorate, Manufacture of" (review), 57
Precipitates, apparatus for washing, 256
Propyl alcohol and water, mixture of, 263
Propylene iodide, production of, 268, 293
transformation of, 48
Prost, E., extraction of lead from the residues of the production of zinc, 37
Pyrites, determination of arsenic in, 49
Pyrocresol, new colouring-matters of, 288

QUANTIN, M., determination of nitrogen, 268
Queen's College, Belfast, 146
Cork, 147
Quinine, estimation of by Kerner's method, 202, 216, 226

RAILS, rusting of, 262
Ramsay, M., and M. Young, mixture of propyl alcohol and water, 263
Raoult, F., vapour tensions of alcoholic solutions, 132
Rathgen, F., determination of sugar in liqueurs, &c., 196
Raulin, J., action of micro-organisms on colouring-matters, 132
Rawson, S. G., preparation of boron, 283
Reese, L., new method of determining ashes, 62
Reinhardt, C., determination of manganese in slightly manganiferous cast-iron, 173
mercury valve in place of glass and pinch-cocks, 256
Resins and gums, chemical examination of certain, 224
Resorcine, nitro-nitroso-, 59
Resorcinol as a test for nitrates, 176
Reverdin, F., and C. de la Harpe, determination of para-nitrotoluene, 220
nitro-nitroso-resorcine, 59
Reynolds, J. E., silicon compounds and their derivatives, 283
silico-organic compounds of a new type, 272
Rhinanthin, 99
Rhodium salts, 71
Riban, J., determination of zinc, 90
Rideal, S., action of ammonia on some tungsten compounds, 289
Richards, T. W., atomic weight of copper, 55
relation of the atomic weights of copper and silver, 69
and J. P. Cooke, relative values of the weights of hydrogen and oxygen, 7, 17, 30, 52
Richardson, B. W., "The Asclepiad" (review), 316
Richardson, W. H., new salts of phenylhydrazine, 39
probable orthoquinone derived from anthraquinone, 54
Romanis, R., tectoquinone, 290
Roques, X., composition of brandies, 244
Rothwell, C. F. S, troublesome stoppers, 121
Rousseau, G., and J. Bernheim, certain hydrates of potassium ferrite crystallised in the dry way, 71
decomposition of barium ferrate, 12
Roux, M., and E. Louise, molecular weights of the aluminium compounds, 293
Royal Agricultural College, Cirencester, 141
College of Science for Ireland, 147
Institution, 24, 257, 281, 305
Royal Society, 279, 298
Victoria Hall, 148
Rücker, A. W., optical model, 10
suppressed dimensions of physical quantities, 265
Ruddiman, E. A., estimation of quinine by Kerner's method, 202, 216, 226

SABATIER, P., hydrochlorate of cupric chloride, 220
cobalt chloride hydrochlorate, 36, 59
cupric chloride hydrochlorate, 245
Sabine, W. C., and J. Trowbridge, selective absorption of metals for ultra violet light, 216
wave-lengths of metallic spectra in ultra violet, 237, 247
Saccharine, 184, 196
antipyrine and antifebrine, tests for so-called, 51, 155
in food, detection of, 72
Saccharomyces ellipsoideus, 36
Sachose, E., and Co., "Guide-book for Distillers" (review), 182
Salkowski, E., modification of the soda test, 208
Salicylic acid, 256
Salt, cerium, of chinoline, 199
Salts of copper, alleged reagent, 293
new reagent for, 184
of hydrazine, new, 39
Sanitation of towns, 36
Sansone, A., "Dyeing" (review), 242
Sealed papers, 259
Sea-water, determination of bromine in, 190
Seaweed dye, 15
Selenium and bromine, limit of refraction, 252
Seward, M., and W. H. Pendlebury, investigation of a case of gradual chemical change, 308
Sexton, H. A., "Outlines of Qualitative Analysis" (review), 219
Schiff, H., detection of furfurol, 49
Schindler, C., volumetric determination of molybdic acid and of lead, 61
of phosphoric acid, 61
Schlœsing, T., nitrogen in vegetable soils, 83
Schmidt, W., determination of fat in milk and cream, 197
Scholvein, M., recognition of sulphonal, 257
School of Medicine, Edinburgh, 149
of Pharmacy, 147
Schools of chemistry, 136
Schott, O., glass working with blowpipe, 184
Schwartz, G., determination of lead in tin alloys, 209
Schwarz, C., direct detection of chloral, 257
Science and Art Department, 257, 305, 317
Durham College, 143
Scientific units of measurement, system of, 291
Shaumann, H., determination of albumen in urine, 245
Sheffield Borough Assistant's Laboratory, 149
Firth College, 144
Shimer, P. W., determination of phosphorus in iron and steel, 165
Sidersky, D., indirect determination of alcohol, 184
Silicates, analysis of natural, 182
for analysis, decomposition of, 310
Silicon compounds and their derivatives, 283
hydride, 215
Silico-organic compound, 272
Silver and copper atomic weights, reaction of, 69
chloride, cyanide, &c., analysis of a mixture, 232
nickel, analysis of, 48
nitrate, 24
Slags, detection of bismuth and lithium in, 27
Slatter, G. W., improved wash-bottle, 171
Smith, R. W., and G. G. Henderson, action of chromium oxychloride on pinene, 290
"Smithsonian Report" (review), 181
Soaps, fatty acids in, 60
Society, Chemical, 21, 239, 262, 287
Mulhouse Industrial, 196
of Arts, 233
Physical, 10, 252, 265, 291
Royal, 279, 298
Soda preparation, 132
test, modification of, 208
Sodium and potassium carbonate, new double, 53
chloride, determination of, 172
disulpho-persulphate, properties of, 183
hypobromite, action of, 232
phosphate, detection of, 48
Soils, analysis of, 196
Solar spectrum, photography of, 311
Solution, theory of, 151
Sonnenschein, A., acetic acid in acetates, determination, 60
Soret, A., occlusion of gases in the electrolysis of copper sulphate, 255
South London School of Pharmacy, 148
Specific heats of gases at constant volume, 271
Spectra, absorption, rare earths which produce, 75, 91
Spectroscopic detection of blood, 37
Spectrum, absorption, of oxygen, 163
of oxygen, 244
Spices, powdered, examination of, 48
Spiller, J., analysis of the ancient mortar from the Roman wall of London, 189
Spring, W., metallic lustre, 269
rusting of rails, 262
and C. Winssinger, action of chlorine, 12
Spirits, detection of fusel in, 60
Spongine, constitution of, 72
Starch paste in volumetric analyses, 245
St. Andrew's University, 146
Steel and iron, determination of phosphorus in, 165
manganese, 172
Steels, manganese in determination of, 209
Stevens Institute of Technology, 13
Stolba, F., incineration of coke and graphite, 197
Stokes, A. W., arsenic in the home, 189
Stone, cleansing, 185, 245
Stoppers, refractory, 121
Strecker, T., and E. Noelting, iodophenols, 36
Strontium and barium, separation of calcium from, 60
Strophantine, elementary composition of crystalline, 59
Student's address, 135
Substances, elementary, announced from 1877 to 1887, 188
Succinic acid, action of ethylene diamine, 241
Sugar in liqueurs, determination of, 196
in urine, detection of, 109
Sulphide, hydrogen, action of, 256
of hydrogen in urine, detection, 160
Sulphides of strontium and calcium, preparation of, 305

Sulphides, dissociation in fused metallic, 87
Sulphines, 37
Sulphite of barium, 128, 155
Sulphonal, recognition of, 257
Sulphur and phosphorus, dissemination of, 177
chloride on oils, action of, 4
determination of, 96, 208
dioxide apparatus, new form of, 187
in coke, determination of, 65
influence of on Eggertz's carbon colour test, 175
in iron, 255
in iron and steel, determination of, 63, 71, 95
in steel and steel-making iron, estimation, 41, 59, 95
new oxy-acid of, 36
Sulphuretted hydrogen, cheap apparatus for generating, 99, 123
method of generating pure non-arseniferous, 48
Sulphonic acids, isomeric, 263
Sulphuric acid, volumetric determination of, 72
Sulphurous acid and iodometry, 49
Symmetry, criteria of plane and axial, 240
Symons, H. H., "Chemical Laboratory Labels" (review), 254

TACKE, B., generating pure oxygen in quantity, 207
Tannin estimation, 71
Tartaric acid, improved method for the analysis of materials containing, 37
Tartrate solutions, circular polarisation of certain, 313
Technical College, Bradford, 151
for Glasgow and the West of Scotland, 145
instruction, 13
terms, French, 11
"Technical Education" (review), 58
Technology, Stevens Institute, 13
Tectoquinone, 290
Terebenthenes, action of crystalline formic acid on, 11
Terpenes, constitution of, and of benzene, 239
Terpilene into menthene, transformation of, 304
Tertiary phosphines, mixed, 22
Tetraphenyl-ethylene, new process for preparing, 37
Thermo-chemistry, principles of, 262
Thionyl thiocyanate, 290
Thompson, S. P., continuous current transformers, 10
experiments on glass in polarised light, 253
Thompson, C. M., and J. T. Cundall, action of potassium, 22
Thompson, R. H., and R. W. Davey, "Essay on Cramming" (review), 267
Thompson's calorimeter, industrial value of, 37
Thomson, J. J., "Application of Dynamics to Physics and Chemistry" (review), 36
Thomson, A., and T. Carnelley, solubility of isomeric organic compounds, 22
Thudichum, Dr., alkaloids, 24
Tibus, M., earrings, 257
Tidy, C. M., poisons and poisoning, 33, 44
W. Odling, and W. Crookes, London water supply, 46, 91, 176, 195, 252, 310
Tiessier, J., analysis of a mixture of silver chloride, cyanide, &c., 232
Tilden, W. A., address to Chemical Section of British Association, 123
constitution of the terpenes and of benzene, 239
Tin, 251
alloys, determination of lead in, 109
arsenic and antimony, separating, 96
Tissue-printing, dyeing, and bleaching, improvements, 161
Titanates, four new zinc, 108
Tolane, hydration of, 24
Toluensulphonic acids, formation of isomeric, 21
Toluidines with phosphoric acid, behaviour of, 184
Tolyl-propionic acid, synthetic formation of, 25
Tomicek, F., and M. Brauner, action of sulphuretted hydrogen on arsenic acid, 208
Tomlinson, C., bumping ebullition, 235
Towns, sanitation of, 36
"Townson and Mercer's Catalogue of Chemical and Physical Apparatus and Chemicals" (review), 292
Toxicological detection of bromine and iodine, 208
Trinity College, Dublin, 136
Trowbridge, J., and W. C. Sabine, selective absorption of metals for ultra violet light, 216
wave-lengths of metallic spectra in the ultra violet, 237, 247
Tungsten compounds, action of ammonia on, 289
Tuson, Prof. Richard Vine, Obituary, 230

UEHLING, A., simplification of the calculation of analyses, 197
Uffelmann, M., detection of fusel in spirits, 60
Ulsch, K., drying apparatus, 207
Kjeldahl's determination of nitrogen, 49
University College, 137
Liverpool, 142
Nottingham, 144
presentation of portrait of Prof. Williamson, 302
Universities and colleges, 135
Urine, detection of aniline, 61
of hydrogen sulphide in, 160
of sugar in, 109
determination of albumen, 245

VAPOUR-DENSITIES, new method of determining, 288
tensions of alcoholic solutions, 132
Veley, V. H., formation of oxygen, 260
Venable, F. P., new test for iron, 178
Vermillionette, 185
Verneuil, A., hexagonal phosphorescent blende, 47
Victoria University, 141
Villard, M., methane and ethylene hydrates, 96
Villiers, A., properties of sodium disulpho-persulphate, 183
new oxy-acid of sulphur, 36
Vignon, L., acid sulphates of dimethyl-aniline and diphenylamine, 268
Vignon, L., aromatic monamines, 12
determining carbonic acid in solution, 293
general reaction of the acid sulphates of some aromatic bases, 72
researches on paraphenylen-diamine, &c., 244
tin, 251
Violet, ultra, wave-lengths of metallic spectra in, 237, 247, 304
Vitali, M., toxicological detection of bromine and iodine, 208
Volhard, J., sulphurous acid and iodometry, 49
Voltaic balance, 64
couple by variation of strength of its liquid, change of potential of, 15
couples, effect of positive metals on the changes of potential, 51
Volumetric determination of molybdic acid and of lead, 61

WAGHORNE, J. W. W., determining electro-magnetic capacity, 291
Wahl, A., apparatus for washing precipitates, 256
Wahl, W. H., rewards for meritorious discoveries and inventions, 243
Wales, University College, 139
Walfisez, A., and S. Gniewosz, absorption of gases, 256
Wallace, Dr., Obituary, 266
Warden, C. J. H., note on erythroxylon coca grown in India, 249, 260, 273
Warren, C. A., estimating aluminium with sodium thiosulphate, 109
Warren, H. N., action of ammonia on metallic magnesium, 297
catalysis of potassium chlorate and manganese dioxide, 247
detection and estimation of bismuth and lithium in metallic iron and slags, 27
dissemination of sulphur and phosphorus, 177
electrical dialysis, 76
electrolytic method of liquefying gases, 127
silicon hydride, 215
sulphur in iron, 255
Warren, T. T. P. B., action of sulphur chloride on oils, &c., 4, 15
adulteration of coal-tar naphtha, 235, 247
arsenic in the home, 206
mathematical investigation of chemical phenomena, 47
sensibility of earth-nut oil to heat when electrified, 259
valuation of oil-cake, 211
waterproofing, 242
water supply to steam-boilers, 273
Wash-bottle, improved, 171, 182
Watches, palladium alloys in, 100
Water, analysis of Nile, 71
and propyl alcohol, mixture, 263
crystalline, of the alums, 220
examination of, 49
softening, quantities of lime and soda for, 84
sprengels, 207
supply of London, 46, 91, 176, 195, 252, 310
to steam-boilers, 273
Waters, black, of the equatorial regions, 305
Waterproofing, 233, 243, 245
"Waterworks Statistics" (review), 160
Watery vapour from moist air by solids, absorption of, 197
Watson, G., Liebreich's dead space in chemical reactions, 297
Weight of bodies, changes, 256
Weights, atomic, standard of, 307
of hydrogen and oxygen, relative values of the, 7, 17, 30, 52
Welch, J. C., analyses of two moneys, 164
Westcott, W. W., "Medical References" (review) 160
Westmoreland, J. W., Dr. Peters's American methods of copper smelting, 76, 131
White, J. T., modified absorption tubes, 166
volumetric determination of chlorine, 229
White-lead, constitution of, 220
"Whittaker's Almanack" (review, 316
Wiesbaden chemical laboratory, 121
Williams, G., cerium salt of chinoline, 199
R., amount of morphia in opium, 27
ancient mortars, 231
chemical examination of certain gums and resins, 224
determination of copper, 272
estimation of alumina, 24
R. P., "Laboratory Manual of General Chemistry" (review), 253
Williamson, Dr. A. W., dinner to, 281
presentation portrait to University College, 302
Winckler, C., method for generating pure non-arseniferous sulphuretted hydrogen, 48
Winder, B. W., estimation of sulphur in iron and steel, 95
Windisch, W., detection of aldehyd, 208
Wine, determination of nitric acid in, 133
Wines, detection of nitric acid in, 84
Winssinger, C., colloidal state, 25
and W. Spring, action of chlorine, 12
Witt, R. O., water-sprengels, 207
Wynne, W. P., and H. E. Armstrong, constitution of the dichloronaphthalenes, 264

YARAQUE, a fermented drink, 256
Yates, H. N., analysis of ferro-aluminium, 11
Yeast, analysis of brewer's, 256
Yorkshire College, Leeds, 141
Young, S., and W. Ramsay, mixture of propyl alcohol and water, 263
Yttrium and potassium or sodium phosphates, certain double, 232
Yttrium, certain compounds of, 48

ZALOCOSTAS, P., constitution of spongine, 72
Zimmermann, A., separation of alumina and glucina, 49
Zinc, lead extraction from the residues of the production of, 37
quantitative determination of, 84, 90
titanates, four new, 108

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